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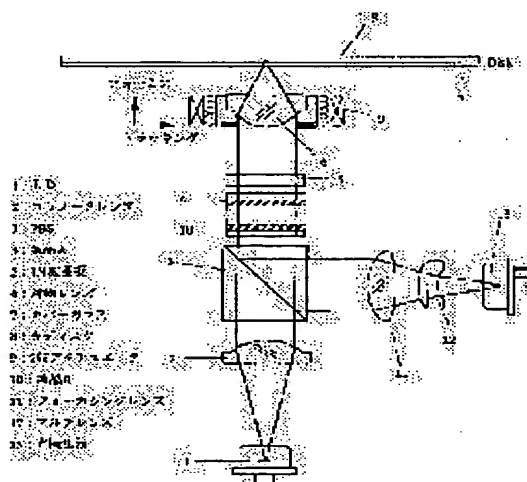
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(54) OPTICAL PICKUP AND ITS WAVE FRONT ABERRATION CORRECTING DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To appropriately correct wave front aberration caused in an optical system by a liquid crystal element without being affected by a quarter wave plate disposed on an optical path from a light source via a recording medium to a light detector.

SOLUTION: A liquid crystal element A4 is disposed at an advancing light path (a first light path) from the laser light source 1 to an optical disk 8 so as to align a liquid crystal in a polarization direction of light made incident into the optical disk 8 to correct the aberration of advancing light. Separately from the liquid crystal element A4, a liquid crystal element B10 is additionally disposed at returning light path (a second light path) from the quarter plate 5 to the light detector 13 so as to align the liquid crystal in the polarization direction of returning light to correct the aberration of the returning light. Thus, since the polarization states of advancing light and returning light are different from each other by 90 degrees, respective aberrations are independently corrected.



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CLAIMS

[Claim(s)]

[Claim 1] The optical pickup characterized by what the 2nd liquid crystal device for wave aberration amendment was prepared for in the 2nd optical path to a photodetector from said optical recording medium while preparing the 1st liquid crystal device for wave aberration amendment in the 1st optical path to an optical recording medium from said light source in the optical pickup of the information recorded on said optical recording medium by carrying out incidence of the light from the light source to an optical recording medium, and detecting the reflected light with a photodetector reproduced at least.

[Claim 2] The objective lens for making the information recording surface of said optical recording medium condense the light by which outgoing radiation was carried out from said light source, While being arranged between the phase control component arranged between said light sources and objective lenses, and said light source and phase control component and leading the light from said light source to an optical-recording-medium side [It is the optical pickup according to claim 1 characterized by having the optical branching component which leads the reflected light from said optical recording medium to said photodetector, arranging said 1st liquid crystal device between said light sources and objective lenses, and arranging said 2nd liquid crystal device between said phase control components and photodetectors.

[Claim 3] It is the optical pickup according to claim 2 characterized by having arranged said 1st liquid crystal device so that orientation of the liquid crystal may be carried out in the polarization direction of the light which carries out incidence to said optical recording medium, and having arranged said 2nd liquid crystal device so that orientation of the liquid crystal may be carried out in the polarization direction of the light which carries out incidence to said photodetector.

[Claim 4] Said the 1st liquid crystal device and 2nd liquid crystal device are an optical pickup according to claim 2 characterized by being arranged between said phase control component and an optical branching component.

[Claim 5] It is the optical pickup according to claim 2 characterized by arranging said 1st liquid crystal device between said phase control component and an optical branching component, and arranging said 2nd liquid crystal device between said optical branching components and photodetectors.

[Claim 6] It is the optical pickup according to claim 2 characterized by arranging said 1st liquid crystal device between said light source and an optical branching component, and arranging said 2nd liquid crystal device between said optical branching components and photodetectors.

[Claim 7] The optical pickup according to claim 1 characterized by consisting of a liquid crystal device with which said the 1st liquid crystal device and 2nd liquid crystal device were united by sharing a middle substrate.

[Claim 8] Said phase control component is an optical pickup according to claim 2 characterized by being a quarter-wave length plate.

[Claim 9] Said optical branching component is an optical pickup according to claim 2 characterized by being a polarization beam splitter.

[Claim 10] Said optical recording medium is an optical pickup according to claim 1 characterized by being a disk mold medium.

[Claim 11] Said light source is an optical pickup according to claim 1 characterized by being the laser light source.

[Claim 12] By carrying out incidence of the light from the light source to an optical recording medium, and detecting the reflected light with a photodetector In the wave aberration compensator of the optical pickup of the information recorded on said optical recording medium reproduced at least The wave aberration compensator of the optical pickup characterized by having the 1st liquid crystal device for wave aberration amendment arranged at the 1st optical path to an optical recording medium from said light source, and the 2nd liquid crystal device for wave aberration amendment arranged at the 2nd optical path to a photodetector from said optical recording medium.

[Claim 13] An objective lens for said optical pickup to make the information recording surface of said optical recording medium condense the light by which outgoing radiation was carried out from said light source, While being arranged between the phase control component arranged between said light sources and objective lenses, and said light source and phase control component and leading the light from said light source to an optical-recording-medium side It has the optical branching component which leads the reflected light from said optical recording medium to said photodetector. It is the wave aberration compensator of the optical pickup according to claim 12 characterized by arranging said 1st liquid crystal device between said light sources and objective lenses, and arranging said 2nd liquid crystal device between said phase control components and photodetectors.

[Claim 14] It is the wave aberration compensator of the optical pickup according to claim 13 characterized by having arranged said 1st liquid crystal device so that orientation of the liquid crystal may be carried out in the polarization direction of the light which carries out incidence to said optical recording medium, and having arranged said 2nd liquid crystal device so that orientation of the liquid crystal may be carried out in the polarization direction of the light which carries out incidence to said photodetector.

[Claim 15] Said the 1st liquid crystal device and 2nd liquid crystal device are the wave aberration compensator of the optical pickup according to claim 13 characterized by being arranged between said phase control component and an optical branching component.

[Claim 16] It is the wave aberration compensator of the optical pickup according to claim 13 characterized by arranging said 1st liquid crystal device between said phase control component and said optical branching component, and arranging said 2nd liquid crystal device between said optical branching components and photodetectors.

[Claim 17] It is the wave aberration compensator of the optical pickup according to claim 13 characterized by arranging said 1st liquid crystal device between said light source and an optical branching component, and arranging said 2nd liquid crystal device between said optical branching components and photodetectors.

[Claim 18] The wave aberration compensator of the optical pickup according to claim 12 characterized by consisting of a liquid crystal device with which said the 1st liquid crystal device and 2nd liquid crystal device were united by sharing a middle substrate.

[Claim 19] Said phase control component is the wave aberration compensator of the optical pickup according to claim 13 characterized by being a quarter-wave length plate.

[Claim 20] Said optical branching component is the wave aberration compensator of the optical pickup according to claim 13 characterized by being a polarization beam splitter.

[Claim 21] Said optical recording medium is the wave aberration compensator of the optical pickup according to claim 12 characterized by being a disk mold medium.

[Claim 22] Said light source is the wave aberration compensator of the optical pickup according to claim 12 characterized by being the laser light source.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the optical pickup used for various optical recording and/or regenerative apparatus, such as an optical disc system, an optical MAG disc system, and an optical card system, and its wave aberration compensator.

[0002]

[Description of the Prior Art] In recent years, in order to raise the storage capacity of an optical disk in various kinds of record/regenerative apparatus using an optical disk, the semiconductor laser (LD) of short wavelength is used as the light source of an optical pickup, and the lens with a numerical aperture NA high as an objective lens is used. That is, with CD, with 780nm and DVD, like 650nm, the wavelength of the laser used for the light source of an optical pickup is short as recording density becomes high. On the other hand, NA of an objective lens is large as recording density becomes high like [NA / in CD it is called 0.45, and / DVD] 0.60. Moreover, recently, the high NA objective lens 0.85 is used for development of an optical disk with LD of the purple-blue color of 405nm.

[0003] However, if the wavelength of LD becomes short in this way and NA of an objective lens becomes large, wave aberration will increase easily to various manufacture errors, and the problem that optical-character ability deteriorates will arise. Then, more various approaches than before can be considered as an approach of amending this wave aberration, and there is a method of using a liquid crystal device for one of them. This inserts a liquid crystal device between laser and an objective lens, and gives desired phase distribution to the transmitted light. That is, a non-aberration condition is acquired in respect of image formation by giving a phase contrary to wave aberration beforehand to the incident light of an objective lens.

[0004] Hereafter, how to give phase distribution to the transmitted light by the liquid crystal device is explained. First, the glass flat-surface substrate is usually used for two substrates which generally close the liquid crystal molecule of a liquid crystal device, and the electrode is formed in these glass substrates so that an electrical potential difference can be impressed to liquid crystal. And the liquid crystal molecule by which the closure is carried out into these glass substrates is located in a line along with the orientation film formed in each glass substrate, and can carry out the variation rate of the molecular arrangement by impressing an electrical potential difference to the electrode of each glass substrate. And since a refractive index changes in connection with the variation rate of this liquid crystal molecule to the polarization component of a direction which met the orientation film, it is possible to change the phase of the transmitted light. On the other hand, to polarization of the orientation film and the rectangular direction, irrespective of impression of an electrical potential difference, since a refractive index is fixed, a phase change does not happen.

[0005] Next, what is necessary is just to make the distribution of voltage impressed to liquid crystal, in order to give phase distribution to the transmitted light of polarization parallel to such orientation film. As an easy approach for that, an electrode is formed with the electrode divided or more into at least two, and there is a method of applying separately the electrical potential difference according to desired phase distribution to these electrodes. By such approach, the

distribution of voltage corresponding to the number of electrodes and applied voltage is formed, and it becomes possible to give desired phase distribution in approximation to the transmitted light. In this case, such ideal phase distribution can be generated that the number of partitions is fine, of course.

[0006] Moreover, there is the approach of constituting the field configuration of the field which puts the liquid crystal of each glass substrate as other methods of giving the distribution of voltage impressed to liquid crystal, so that the thickness of a liquid crystal molecule may serve as phase distribution and the similarity configuration of aberration. In this case, an electrode is formed in solid one to each substrate side, without dividing. And a uniform electrical potential difference is impressed to an electrode. By this approach, phase distribution of the transmitted light is decided by the thickness of the liquid crystal molecule to penetrate, and the electrical potential difference to impress. And if phase distribution contrary to the wave aberration which optical system in case there is no liquid crystal device in the transmitted light has is given, in respect of image formation, it will become non-aberration.

[0007]

[Problem(s) to be Solved by the Invention] However, in the wave aberration amendment means using the above liquid crystal devices, there are the following troubles generated in the optical path from a record medium to a photodetector. That is, when performing record / playback of a phase change mold disk, or playback of a ROM disk, for example, the polarization condition will lie at right angles by the optical path from laser to a quarter-wave length plate (henceforth $\lambda/4$ plate), and the optical path from $\lambda/4$ plate to a photodetector. Therefore, by the optical path from $\lambda/4$ plate to a photodetector, even if it amends the aberration of the optical system of the optical path from laser to a record medium using a liquid crystal device, since the orientation film and polarization lie at right angles, the aberration of the optical path from a record medium to a photodetector is not amended. If a detection system detects a signal in this condition, when big aberration remains in the optical path from a record medium to a photodetector, the spot on a photodetector expands or deforms, exact detection becomes impossible and the problem that good record/playback cannot be performed arises.

[0008] Then, the purpose of this invention is to offer the optical pickup which can amend the wave aberration produced in optical system proper by the liquid crystal device, and its wave aberration compensator, without being influenced by the light source of the wavelength plate arranged on the optical path which results in a photodetector through a record medium.

[0009]

[Means for Solving the Problem] This invention by carrying out incidence of the light from the light source to an optical recording medium, and detecting the reflected light with a photodetector, in order to attain said purpose While preparing the 1st liquid crystal device for wave aberration amendment in the 1st optical path to an optical recording medium from said light source in the optical pickup of the information recorded on said optical recording medium reproduced at least It is characterized by preparing the 2nd liquid crystal device for wave aberration amendment in the 2nd optical path to a photodetector from said optical recording medium. This invention moreover, by carrying out incidence of the light from the light source to an optical recording medium, and detecting the reflected light with a photodetector In the wave aberration compensator of the optical pickup of the information recorded on said optical recording medium reproduced at least It is characterized by having the 1st liquid crystal device for wave aberration amendment arranged at the 1st optical path to an optical recording medium from said light source, and the 2nd liquid crystal device for wave aberration amendment arranged at the 2nd optical path to a photodetector from said optical recording medium.

[0010] In the optical pickup of this invention, the 1st liquid crystal device for wave aberration amendment is prepared in the 1st optical path to an optical recording medium from the light source, and the wave aberration of the light which carries out incidence to an optical recording medium is amended. Moreover, the 2nd liquid crystal device for wave aberration amendment is prepared in the 2nd optical path to a photodetector from an optical recording medium, and the wave aberration of the light which reflects from an optical recording medium and carries out incidence to a photodetector is amended. Therefore, since the aberration of the optical path

from an optical recording medium to a photodetector can also be amended by having newly prepared especially the 2nd liquid crystal device, the good detection condition of a focal error signal, a tracking error signal, and a RF signal becomes possible, for example, and it becomes possible to contribute to the improvement in the engine performance of the optical pickup in the case of amending big aberration.

[0011] Moreover, with the wave aberration compensator of this invention, similarly, the 1st liquid crystal device for wave aberration amendment is prepared in the 1st optical path to an optical recording medium from the light source, and the wave aberration of the light which carries out incidence to an optical recording medium is amended. Moreover, the 2nd liquid crystal device for wave aberration amendment is prepared in the 2nd optical path to a photodetector from an optical recording medium, and the wave aberration of the light which reflects from an optical recording medium and carries out incidence to a photodetector is amended. Therefore, since the aberration of the optical path from an optical recording medium to a photodetector can also be amended by having newly prepared especially the 2nd liquid crystal device, the good detection condition of a focal error signal, a tracking error signal, and a RF signal becomes possible, for example, and it becomes possible to contribute to the improvement in the engine performance of the optical pickup in the case of amending big aberration.

[0012]

[Embodiment of the Invention] Hereafter, the gestalt of operation of the optical pickup by this invention and its wave aberration compensator is explained. In addition, in the following explanation, although the gestalt of the operation explained below is the suitable example of this invention and desirable various limitation is attached technically, especially the range of this invention shall not be limited to these modes, as long as there is no publication of the purport which limits this invention.

[0013] With the gestalt of this operation, as additional arrangement of the liquid crystal device is carried out and orientation of the liquid crystal is carried out to the optical path (the 2nd optical path) from $\lambda/4$ plate to a photodetector in the polarization direction of return light apart from the liquid crystal device of the optical path (the 1st optical path) from the laser light source in the conventional example mentioned above to a record medium, the aberration of return is amended. Since polarization conditions differ 90 degrees by going and return, aberration is independently amended by such configuration, respectively. As long as the location which arranges this liquid crystal device is the optical path of return, it may be good anywhere, and it may be a location where return has lapped with going.

[0014] Consequently, also in the optical path from a record medium to a photodetector, wave aberration can be amended good. Therefore, it becomes possible to perform record/playback good, without the spot on a photodetector expanding or deforming. In addition, since the aberration generally generated in the 1st optical path from laser to $\lambda/4$ plate and the aberration generated in the 2nd optical path from a record medium to a photodetector are mutually equal, the amount of amendments of the liquid crystal device which amends the aberration of the 1st optical path from laser to $\lambda/4$ plate, and the liquid crystal device which amends the aberration of the 2nd optical path from a record medium to a photodetector is the same, and good. That is, the amount and distribution which orientation only lies at right angles and control the liquid crystal device of two sheets will become the same.

[0015] Hereafter, the concrete example in the gestalt of this operation is explained to a detail using a drawing.

(The 1st example) Drawing 1 is the approximate account Fig. showing the configuration of the optical system of the optical pickup by the 1st example of this invention. An optical disk 8 is a phase change mold disk or a ROM disk of a metal membrane, cover glass 7 is penetrated, laser light is irradiated by the signal recording surface, and the pit pattern recorded on the signal recording surface is read by the optical pickup. An optical pickup has the biaxial actuator 9 carrying an objective lens 6, by drive control of this biaxial actuator 9, moves an objective lens 6 in the direction of a focus, and the direction of tracking, and performs access to an optical disk 8.

[0016] A collimator lens 2, a polarization beam splitter (optical branching component) 3, liquid

crystal device A4, the liquid crystal device B10, and the quarter-wave length plate (phase control component) 5 are formed in the optical path between the laser light source (LD) 1 and an objective lens 6. Moreover, the focusing glass 11 and the multi-lens 12 are formed in the optical path of a polarization beam splitter 3 and a photodetector 13. Among these, liquid crystal device A4 and a liquid crystal device B10 constitute the wave aberration compensator in this gestalt, liquid crystal device A4 amends the wave aberration of the laser light which carries out incidence to an optical disk 8 from LD1, and a liquid crystal device B10 amends the wave aberration of the return laser light reflected with the optical disk 8. In addition, since it is the same configuration as usual, others are omitted for details.

[0017] Next, the configuration and actuation of a wave aberration compensator in the optical pickup of such this gestalt are explained. Drawing 2 is liquid crystal device A4 used by this example, and the explanatory view showing the structure of B10. Liquid crystal device A4 used by this example and B10 change and arrange the include angle of the liquid crystal device 20 which has common structure mutually, drawing 2 (A) shows the condition at the time of power-source OFF of a liquid crystal device 20, and drawing 2 (B) shows the condition at the time of power-source ON of a liquid crystal device 20. Moreover, drawing 2 (C) shows the forward plane structure of the electrode of a liquid crystal device 20. Like illustration, the liquid crystal device 20 of this example closes the liquid crystal molecule 23 with the glass substrates 21 and 22 of a pair. The electrode layers 24 and 25 for impressing an electrical potential difference to liquid crystal are formed in the opposed face of each glass substrates 21 and 22 according to the power source 26, and the orientation film 27 and 28 is further formed inside each electrode layers 24 and 25. Moreover, as shown in drawing 2 (C), each electrode layers 24 and 25 are divided in the shape of a concentric circle, and acquire the distribution of voltage impressed to liquid crystal by impressing the electrical potential difference of level which is different in each division electrode layer.

[0018] Such a liquid crystal device 20 has the array of the liquid crystal molecule which met the orientation film 27 and 28 at the time of OFF of a power source 26, as shown in drawing 2 (A). And since the liquid crystal molecule which was lying down along the direction of a field of each substrates 21 and 22 will start and a refractive index will change as shown in drawing 2 (B) if a power source 26 is turned on, it is possible to give phase distribution to the transmitted light. In this example, the variation rate of the phase distribution is carried out by the liquid crystal device B10 to the linearly polarized light of the laser light of the return trip (return) which is made to carry out the variation rate of the phase distribution, reflects from an optical disk 8, and carries out incidence to a photodetector 13 by liquid crystal device A4 to the linearly polarized light of the laser light of the outward trip (going) which carries out incidence to an optical disk 8 by using such a liquid crystal device 20 for liquid crystal device A4 and B10.

[0019] In addition, although the distribution of voltage impressed to liquid crystal with a division electrode was acquired in the liquid crystal device 20 shown in drawing 2, the liquid crystal device 30 constituted so that a substrate configuration might instead be deformed and the thickness of a liquid crystal molecule might serve as phase distribution and the similarity configuration of aberration, as shown in drawing 3 may be used. That is, in the example shown in drawing 3, the medial surface of one glass substrate 31 of a liquid crystal device 30 has a curvilinear configuration respectively like illustration, and solid formation of the orientation film 37 and the electrode layer 34 is carried out at the medial surface of these glass substrates 31. Moreover, as shown in drawing 3 (C), the electrode layers 34 and 35 of a liquid crystal device 30 are not divided, respectively, but an electrical potential difference common to the whole is impressed according to a power source 36. In addition, the glass substrate 32 and the liquid crystal molecule 33 of another side, and electrode layer 35 grade are as common as the example shown in drawing 2 mentioned above. Also in liquid crystal device A4 using such a liquid crystal device 30, and B10, liquid crystal device A4 mentioned above and the same operation as B10 can be acquired.

[0020] Next, actuation of the wave aberration compensator of the above configurations is explained. First, desired phase distribution is given by 1st liquid crystal device A4 to which the linearly polarized light which faces to an optical disk 8 from the polarization beam splitter prism

(PBS) 3 has the orientation film 27 and 28 in the polarization direction. That is, in liquid crystal device A4, since the liquid crystal molecule which was lying down on the front face of each substrates 21 and 22 will start and a refractive index will change if an electrical potential difference is applied to each electrode layers 24 and 25, it is possible to give phase distribution to the transmitted light. On the other hand, since the 2nd liquid crystal device B10 is making the polarization direction and the orientation film cross at right angles, it does not affect the transmitted light in the optical path from LD1 to an optical disk 8. The light which penetrated liquid crystal device A4 turns into the circular polarization of light with $\lambda/4$ plate 5, and is condensed in respect of the signal of an optical disk 8 with an objective lens 6. Here, the aberration of the optical system of an outward trip (going) is amended by the phase distribution given by liquid crystal device A4, and the spot of a diffraction limitation is obtained by the signal recording surface of an optical disk 8.

[0021] Next, the light reflected with the optical disk 8 turns into the linearly polarized light which intersects perpendicularly with an outward trip through $\lambda/4$ plate 5 again. This linearly polarized light can give desired phase distribution by the liquid crystal device B10 which has the orientation film 27 and 28 in that polarization direction. On the other hand, since the polarization direction and the orientation film 27 and 28 are made to cross at right angles in liquid crystal device A4, the transmitted light is not affected in the optical path from $\lambda/4$ plate 5 to a photodetector 13. This amends the aberration of the light which has returned from the signal recording surface of an optical disk 8. The light which penetrated the liquid crystal device B10 is reflected by PBS3, and a focal error signal, a tracking error signal, and a RF signal are detected from the output of this photodetector 13 toward a photodetector 13. Here, if big aberration remains in return light, the spot on a photodetector 13 will expand or deform, exact detection cannot be performed, but in this example, since the aberration of return light is amended by the liquid crystal device B10, good detection is attained. in addition — a liquid crystal device — A4 —
 — a liquid crystal device — B — ten — physical relationship — < — A HREF — = — " — / — Tokujitu/tjitemdrw . — ipdl?N — 0000 — = — 237 — & — N — 0500 — = — one — E_N — / — ; — > — ; — = — : — > — 88 — ; — / — / — / — & — N — 0001 — = — 815 — & — N — 0552 — = — nine — & — N — 0553 — = — 000003 — " — TARGET — = — "tjitemdrw" — > — drawing 1 — being shown — arrangement — reverse — even if — being the same — effectiveness — obtaining — having .

[0022] (The 2nd example) Drawing 4 is the approximate account Fig. showing the configuration of the optical system of the optical pickup by the 2nd example of this invention. This 2nd example changes two liquid crystal device A4 mentioned above and arrangement of B10, and since others are the same as that of the 1st example of the above, a common configuration is explained using the same sign. Although arranged between PBS3 and $\lambda/4$ plate 5 like [A4 / 1st / liquid crystal device] the 1st example in this example, the 2nd liquid crystal device B10 is arranged between PBS3 and a focusing glass 11. In addition, also in this example, the configuration of liquid crystal device A4 and B10 the very thing shall be the same as that of the 1st example, for example, what is shown in drawing 2 or drawing 3 shall be used.

[0023] Next, actuation of the wave aberration compensator of the above configurations is explained. The linearly polarized light which faces to an optical disk 8 from PBS3 can give desired phase distribution by liquid crystal device A4 which has the orientation film 27 and 28 in the polarization direction. The light which penetrated liquid crystal device A4 turns into the circular polarization of light with $\lambda/4$ plate 5, and is condensed by the signal recording surface of an optical disk 8 with an objective lens 6. The aberration of the optical system of an outward trip (going) is amended by the phase distribution given by liquid crystal device A4, and the spot of a diffraction limitation is obtained by the signal recording surface of an optical disk 8. And the light reflected with the optical disk 8 turns into the linearly polarized light which intersects perpendicularly with an outward trip (going) through $\lambda/4$ plate 5 again. This linearly polarized light is reflected by PBS3, and desired phase distribution can be given by the liquid crystal device B10 which has the orientation film in that polarization direction. This amends the aberration of the light which has returned from the signal recording surface of an optical disk 8. As for the light which penetrated the liquid crystal device B10, a focal error signal, a tracking

error signal, and a RF signal are detected toward a photodetector 13. Here, if big aberration remains in return light, the spot on a photodetector 13 will expand or deform, exact detection cannot be performed, but since the aberration of return light is amended by the liquid crystal device B10 in this example, good detection is attained.

[0024] (The 3rd example) Drawing 5 is the approximate account Fig. showing the configuration of the optical system of the optical pickup by the 3rd example of this invention. Two liquid crystal device A4 which also mentioned this 3rd example above, and arrangement of B10 are changed, and since others are the same as that of the 1st example of the above, a common configuration is explained using the same sign. This example is arranged between a collimator lens 2 and PBS3, and 1st liquid crystal device A4 arranges the 2nd liquid crystal device B10 between PBS3 and a focusing glass 11 like the 2nd example. In addition, also in this example, the configuration of liquid crystal device A4 and B10 the very thing shall be the same as that of the 1st example, for example, what is shown in drawing 2 or drawing 3 shall be used.

[0025] Next, actuation of the wave aberration compensator of the above configurations is explained. The linearly polarized light which goes to PBS3 from LD1 can give desired phase distribution by liquid crystal device A4 which has the orientation film 27 and 28 in the polarization direction. The light which penetrated liquid crystal device A4 penetrates PBS3, turns into the circular polarization of light with $\lambda/4$ plate 5, and is condensed by the signal recording surface of an optical disk 8 with an objective lens 6. The aberration of the optical system of an outward trip (going) is amended by the phase distribution given by liquid crystal device A4, and the spot of the signal diffraction limitation of an optical disk 8 is obtained. Moreover, the light reflected with the optical disk 8 turns into the linearly polarized light which intersects perpendicularly with an outward trip (going) through $\lambda/4$ plate 5 again. This linearly polarized light is reflected by PBS3, and desired phase distribution can be given by the liquid crystal device B10 which has the orientation film 27 and 28 in that polarization direction. This amends the aberration of the light which has returned from the signal recording surface of an optical disk 8. And as for the light which penetrated this liquid crystal device B10, a focal signal error, a tracking error signal, and a RF signal are detected toward a photodetector 13. Here, if big aberration remains in return light, the spot on a photodetector 13 will expand or deform, exact detection cannot be performed, but in this example, since the aberration of return light is amended by the liquid crystal device B10, good detection is attained by it.

[0026] (The 4th example) Drawing 6 is the approximate account Fig. showing the configuration of the optical system of the optical pickup by the 4th example of this invention. Two liquid crystal device A4 which also mentioned this 4th example above, and arrangement of B10 are changed, and since others are the same as that of the 1st example of the above, a common configuration is explained using the same sign. This example is arranged between a collimator lens 2 and PBS3 like the 3rd example, and 1st liquid crystal device A4 arranges the 2nd liquid crystal device B10 between PBS3 and $\lambda/4$ plate 5 like the 1st example. In addition, also in this example, the configuration of liquid crystal device A4 and B10 the very thing shall be the same as that of the 1st example, for example, what is shown in drawing 2 or drawing 3 shall be used.

[0027] Next, actuation of the wave aberration compensator of the above configurations is explained. The linearly polarized light which goes to PBS3 from LD1 can give desired phase distribution by liquid crystal device A4 which has the orientation film in the polarization direction. And the light which penetrated this liquid crystal device A4 penetrates PBS3, and it carries out incidence to a liquid crystal device B10. Since this liquid crystal device B10 is making the polarization direction and the orientation film cross at right angles, it does not affect the transmitted light. Next, the light which penetrated liquid crystal device A4 turns into the circular polarization of light with $\lambda/4$ plate 5, and is condensed by the signal recording surface of an optical disk 8 with an objective lens 6. The aberration of such optical system of an outward trip (going) is amended by the phase distribution given by liquid crystal device A4, and the spot of a diffraction limitation is obtained by the signal recording surface of an optical disk 8.

[0028] Next, the light reflected with the optical disk 8 turns into the linearly polarized light which intersects perpendicularly with an outward trip (going) through $\lambda/4$ plate 5 again. This linearly polarized light can give desired phase distribution by the liquid crystal device B10 which

has the orientation film in that polarization direction. This amends the aberration of the light which has returned from the signal recording surface of an optical disk 8. And the light which penetrated this liquid crystal device B10 is reflected by PBS3, and a focal error signal, a tracking error signal, and a RF signal are detected toward a photodetector 13. Here, if big aberration remains in return light, the spot on a photodetector 13 will expand or deform, exact detection cannot be performed, but in this example, since the aberration of return light is amended by the liquid crystal device B10, good detection is attained.

[0029] (The 5th example) Drawing 7 is the approximate account Fig. showing the configuration of the optical system of the optical pickup by the 5th example of this invention. This 5th example is an example which has arranged the liquid crystal device 60 which unified these two liquid crystal devices between PBS3 and $\lambda/4$ plate 5 instead of two liquid crystal device A4 mentioned above and B10, and since others are the same as that of the 1st example of the above, a common configuration is explained using the same sign. Drawing 8 is the sectional view showing the structure of a liquid crystal device 60, drawing 8 (A) shows the condition at the time of power-source OFF, and drawing 8 (B) shows the condition at the time of power-source ON. Moreover, drawing 8 (C) shows the forward plane structure of the electrode of a liquid crystal device 60.

[0030] This liquid crystal device 60 unifies two liquid crystal devices 60A and 60B with the plate-like intermediate glass substrate 61, and like the liquid crystal device 30 which showed the glass substrates 62 and 63 of both sides to drawing 3, it is formed in the shape of [like / in each medial surface / illustration] a curve, and it constitutes them so that the thickness of each liquid crystal molecules 64 and 65 may serve as phase distribution and the similarity configuration of aberration. In liquid crystal device 60A, an electrode layer 70 and the orientation film 72 are formed in the medial surface of the outside glass substrate 62 by solid one, an electrode layer 71 and the orientation film 73 are formed in the medial surface of the intermediate glass substrate 61 at a plane, and the closure of the liquid crystal molecule 64 is carried out between them. The orientation of the liquid crystal molecule 64 of this liquid crystal device 60A is arranged towards return polarization along the substrate side at the time of power-source OFF, as shown in drawing 8 (A).

[0031] On the other hand, in liquid crystal device 60B, an electrode layer 74 and the orientation film 76 are formed in the medial surface of the outside glass substrate 63 by solid one, an electrode layer 75 and the orientation film 77 are formed in the medial surface of the intermediate glass substrate 61 at a plane, and the closure of the liquid crystal molecule 65 is carried out between them. The orientation of the liquid crystal molecule 65 of this liquid crystal device 60B is arranged towards going polarization along the substrate side at the time of power-source OFF, as shown in drawing 8 (A). And in such a liquid crystal device 60, ON of the power sources 66 and 67 of each liquid crystal devices 60A and 60B arranges each liquid crystal molecules 64 and 65 along the transparency direction of light, as shown in drawing 8 (B). In addition, the same effectiveness is acquired even if the physical relationship of liquid crystal device 60A in such a liquid crystal device 60 and liquid crystal device 60B is reverse.

[0032] Next, actuation of the wave aberration compensator of the above configurations is explained. The linearly polarized light which faces to an optical disk 8 from PBS3 penetrates a liquid crystal device 60. As for two liquid crystal devices 60A and 60B which constitute this liquid crystal device 60, the orientation of each liquid crystal molecule can give desired phase distribution by liquid crystal device 60A (liquid crystal device A4) which lies at right angles mutually and has the orientation film in that polarization direction, as for the light of an outward trip (going). Moreover, liquid crystal device 60B (liquid crystal device B10) which has this and the orientation of 90 degrees does not affect phase distribution of light. And the light which penetrated this liquid crystal device 60 turns into the circular polarization of light with $\lambda/4$ plate 5, and is condensed by the signal recording surface of an optical disk 8 with an objective lens 6. The aberration of the optical system of an outward trip (going) is amended by the phase distribution given by liquid crystal device 60A, and the spot of a diffraction limitation is obtained by the signal recording surface of an optical disk 8.

[0033] Next, the light reflected with the optical disk 8 turns into the linearly polarized light which

intersects perpendicularly with an outward trip (going) through $\lambda/4$ plate 5 again. This linearly polarized light can give desired phase distribution by liquid crystal device 60B which has the orientation film in that polarization direction. The aberration of the light which has returned from the signal recording surface of an optical disk 8 by this is amended. Moreover, liquid crystal device 60A which has this and the orientation of 90 degrees does not affect phase distribution of light. The light which penetrated the liquid crystal device 60 is reflected by PBS3, and a focal error signal, a tracking error signal, and a RF signal are detected toward a photodetector 13. Here, if big aberration remains in return light, the spot on a photodetector 13 will expand or deform, exact detection cannot be performed, but since the aberration of return light is amended by liquid crystal device 60B in this example, good detection is attained.

[0034] In addition, it is possible to drive two liquid crystal devices A and B which perform aberration amendment of going and return by the objective lens 6 and one in each above example, and this is desirable. That is, when an objective lens 6 drives in the direction of tracking, eccentricity is carried out to the core of liquid crystal, and there is a possibility that aberration may occur. Then, it is possible to really prevent this by drive. Moreover, although each above example explained the example which used the optical recording medium as the optical disk, this invention is applicable similarly about systems, such as not only this but an optical card, and a magneto-optic disk. Moreover, in this invention, what [not only] carries the light source and a photodetector in an optical head block, and moves to one but the thing of the structure which has arranged the light source and a photodetector fixed independently with the optical head block shall be included with an optical pickup.

[0035]

[Effect of the Invention] The 1st liquid crystal device for wave aberration amendment is prepared in the 1st optical path to [as explained above / according to the optical pickup of this invention] an optical recording medium from the light source, while amending the wave aberration of the light which carries out incidence to an optical recording medium, the 2nd liquid crystal device for wave aberration amendment can be prepared in the 2nd optical path to a photodetector from an optical recording medium, and the wave aberration of the light which reflects from an optical recording medium and carries out incidence to a photodetector can be amended. Therefore, since the aberration of the optical path from an optical recording medium to a photodetector can also be amended by having newly prepared especially the 2nd liquid crystal device, the good detection condition of a focal error signal, a tracking error signal, and a RF signal becomes possible, for example, and it becomes possible to contribute to the improvement in the engine performance of the optical pickup in the case of amending big aberration.

[0036] Moreover, the 1st liquid crystal device for wave aberration amendment is prepared in the 1st optical path to [according to the wave aberration compensator of this invention] an optical recording medium from the light source, and while amending the wave aberration of the light which carries out incidence to an optical recording medium, the wave aberration of the light which prepares the 2nd liquid crystal device for wave aberration amendment in the 2nd optical path to a photodetector from an optical recording medium, reflects from an optical recording medium, and carries out incidence to a photodetector can be amended. Therefore, since the aberration of the optical path from an optical recording medium to a photodetector can also be amended by having newly prepared especially the 2nd liquid crystal device, the good detection condition of a focal error signal, a tracking error signal, and a RF signal becomes possible, for example, and it becomes possible to contribute to the improvement in the engine performance of the optical pickup in the case of amending big aberration.

[Translation done.]

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TECHNICAL FIELD

[Field of the Invention] This invention relates to the optical pickup used for various optical recording and/or regenerative apparatus, such as an optical disc system, an optical MAG disc system, and an optical card system, and its wave aberration compensator.

[Translation done.]

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PRIOR ART

[Description of the Prior Art] In recent years, in order to raise the storage capacity of an optical disk in various kinds of record/regenerative apparatus using an optical disk, the semiconductor laser (LD) of short wavelength is used as the light source of an optical pickup, and the lens with a numerical aperture NA high as an objective lens is used. That is, with CD, with 780nm and DVD, like 650nm, the wavelength of the laser used for the light source of an optical pickup is short as recording density becomes high. On the other hand, NA of an objective lens is large as recording density becomes high like [NA / in CD it is called 0.45, and / DVD] 0.60. Moreover, recently, the high NA objective lens 0.85 is used for development of an optical disk with LD of the purple-blue color of 405nm.

[0003] However, if the wavelength of LD becomes short in this way and NA of an objective lens becomes large, wave aberration will increase easily to various manufacture errors, and the problem that optical-character ability deteriorates will arise. Then, more various approaches than before can be considered as an approach of amending this wave aberration, and there is a method of using a liquid crystal device for one of them. This inserts a liquid crystal device between laser and an objective lens, and gives desired phase distribution to the transmitted light. That is, a non-aberration condition is acquired in respect of image formation by giving a phase contrary to wave aberration beforehand to the incident light of an objective lens.

[0004] Hereafter, how to give phase distribution to the transmitted light by the liquid crystal device is explained. First, the glass flat-surface substrate is usually used for two substrates which generally close the liquid crystal molecule of a liquid crystal device, and the electrode is formed in these glass substrates so that an electrical potential difference can be impressed to liquid crystal. And the liquid crystal molecule by which the closure is carried out into these glass substrates is located in a line along with the orientation film formed in each glass substrate, and can carry out the variation rate of the molecular arrangement by impressing an electrical potential difference to the electrode of each glass substrate. And since a refractive index changes in connection with the variation rate of this liquid crystal molecule to the polarization component of a direction which met the orientation film, it is possible to change the phase of the transmitted light. On the other hand, to polarization of the orientation film and the rectangular direction, irrespective of impression of an electrical potential difference, since a refractive index is fixed, a phase change does not happen.

[0005] Next, what is necessary is just to make the distribution of voltage impressed to liquid crystal, in order to give phase distribution to the transmitted light of polarization parallel to such orientation film. As an easy approach for that, an electrode is formed with the electrode divided or more into at least two, and there is a method of applying separately the electrical potential difference according to desired phase distribution to these electrodes. By such approach, the distribution of voltage corresponding to the number of electrodes and applied voltage is formed, and it becomes possible to give desired phase distribution in approximation to the transmitted light. In this case, such ideal phase distribution can be generated that the number of partitions is fine, of course.

[0006] Moreover, there is the approach of constituting the field configuration of the field which puts the liquid crystal of each glass substrate as other methods of giving the distribution of

voltage impressed to liquid crystal, so that the thickness of a liquid crystal molecule may serve as phase distribution and the similarity configuration of aberration. In this case, an electrode is formed in solid one to each substrate side, without dividing. And a uniform electrical potential difference is impressed to an electrode. By this approach, phase distribution of the transmitted light is decided by the thickness of the liquid crystal molecule to penetrate, and the electrical potential difference to impress. And if phase distribution contrary to the wave aberration which optical system in case there is no liquid crystal device in the transmitted light has is given, in respect of image formation, it will become non-aberration.

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EFFECT OF THE INVENTION

[Effect of the Invention] The 1st liquid crystal device for wave aberration amendment is prepared in the 1st optical path to [as explained above / according to the optical pickup of this invention] an optical recording medium from the light source, while amending the wave aberration of the light which carries out incidence to an optical recording medium, the 2nd liquid crystal device for wave aberration amendment can be prepared in the 2nd optical path to a photodetector from an optical recording medium, and the wave aberration of the light which reflects from an optical recording medium and carries out incidence to a photodetector can be amended. Therefore, since the aberration of the optical path from an optical recording medium to a photodetector can also be amended by having newly prepared especially the 2nd liquid crystal device, the good detection condition of a focal error signal, a tracking error signal, and a RF signal becomes possible, for example, and it becomes possible to contribute to the improvement in the engine performance of the optical pickup in the case of amending big aberration.

[0036] Moreover, the 1st liquid crystal device for wave aberration amendment is prepared in the 1st optical path to [according to the wave aberration compensator of this invention] an optical recording medium from the light source, and while amending the wave aberration of the light which carries out incidence to an optical recording medium, the wave aberration of the light which prepares the 2nd liquid crystal device for wave aberration amendment in the 2nd optical path to a photodetector from an optical recording medium, reflects from an optical recording medium, and carries out incidence to a photodetector can be amended. Therefore, since the aberration of the optical path from an optical recording medium to a photodetector can also be amended by having newly prepared especially the 2nd liquid crystal device, the good detection condition of a focal error signal, a tracking error signal, and a RF signal becomes possible, for example, and it becomes possible to contribute to the improvement in the engine performance of the optical pickup in the case of amending big aberration.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, in the wave aberration amendment means using the above liquid crystal devices, there are the following troubles generated in the optical path from a record medium to a photodetector. That is, when performing record / playback of a phase change mold disk, or playback of a ROM disk, for example, the polarization condition will lie at right angles by the optical path from laser to a quarter-wave length plate (henceforth $\lambda/4$ plate), and the optical path from $\lambda/4$ plate to a photodetector. Therefore, by the optical path from $\lambda/4$ plate to a photodetector, even if it amends the aberration of the optical system of the optical path from laser to a record medium using a liquid crystal device, since the orientation film and polarization lie at right angles, the aberration of the optical path from a record medium to a photodetector is not amended. If a detection system detects a signal in this condition, when big aberration remains in the optical path from a record medium to a photodetector, the spot on a photodetector expands or deforms, exact detection becomes impossible and the problem that good record/playback cannot be performed arises.

[0008] Then, the purpose of this invention is to offer the optical pickup which can amend the wave aberration produced in optical system proper by the liquid crystal device, and its wave aberration compensator, without being influenced by the light source of the wavelength plate arranged on the optical path which results in a photodetector through a record medium.

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MEANS

[Means for Solving the Problem] This invention by carrying out incidence of the light from the light source to an optical recording medium, and detecting the reflected light with a photodetector, in order to attain said purpose While preparing the 1st liquid crystal device for wave aberration amendment in the 1st optical path to an optical recording medium from said light source in the optical pickup of the information recorded on said optical recording medium reproduced at least It is characterized by preparing the 2nd liquid crystal device for wave aberration amendment in the 2nd optical path to a photodetector from said optical recording medium. Moreover, this invention is characterized by the wave aberration compensator of the optical pickup of the information recorded on said optical recording medium reproduced at least possessing the following by carrying out incidence of the light from the light source to an optical recording medium, and detecting the reflected light with a photodetector. The 1st liquid crystal device for wave aberration amendment arranged at the 1st optical path to an optical recording medium from said light source The 2nd liquid crystal device for wave aberration amendment arranged at the 2nd optical path to a photodetector from said optical recording medium [0010] In the optical pickup of this invention, the 1st liquid crystal device for wave aberration amendment is prepared in the 1st optical path to an optical recording medium from the light source, and the wave aberration of the light which carries out incidence to an optical recording medium is amended. Moreover, the 2nd liquid crystal device for wave aberration amendment is prepared in the 2nd optical path to a photodetector from an optical recording medium, and the wave aberration of the light which reflects from an optical recording medium and carries out incidence to a photodetector is amended. Therefore, since the aberration of the optical path from an optical recording medium to a photodetector can also be amended by having newly prepared especially the 2nd liquid crystal device, the good detection condition of a focal error signal, a tracking error signal, and a RF signal becomes possible, for example, and it becomes possible to contribute to the improvement in the engine performance of the optical pickup in the case of amending big aberration.

[0011] Moreover, with the wave aberration compensator of this invention, similarly, the 1st liquid crystal device for wave aberration amendment is prepared in the 1st optical path to an optical recording medium from the light source, and the wave aberration of the light which carries out incidence to an optical recording medium is amended. Moreover, the 2nd liquid crystal device for wave aberration amendment is prepared in the 2nd optical path to a photodetector from an optical recording medium, and the wave aberration of the light which reflects from an optical recording medium and carries out incidence to a photodetector is amended. Therefore, since the aberration of the optical path from an optical recording medium to a photodetector can also be amended by having newly prepared especially the 2nd liquid crystal device, the good detection condition of a focal error signal, a tracking error signal, and a RF signal becomes possible, for example, and it becomes possible to contribute to the improvement in the engine performance of the optical pickup in the case of amending big aberration.

[0012]

[Embodiment of the Invention] Hereafter, the gestalt of operation of the optical pickup by this invention and its wave aberration compensator is explained. In addition, in the following

explanation, although the gestalt of the operation explained below is the suitable example of this invention and desirable various limitation is attached technically, especially the range of this invention shall not be limited to these modes, as long as there is no publication of the purport which limits this invention.

[0013] With the gestalt of this operation, as additional arrangement of the liquid crystal device is carried out and orientation of the liquid crystal is carried out to the optical path (the 2nd optical path) from $\lambda/4$ plate to a photodetector in the polarization direction of return light apart from the liquid crystal device of the optical path (the 1st optical path) from the laser light source in the conventional example mentioned above to a record medium, the aberration of return is amended. Since polarization conditions differ 90 degrees by going and return, aberration is independently amended by such configuration, respectively. As long as the location which arranges this liquid crystal device is the optical path of return, it may be good anywhere, and it may be a location where return has lapped with going.

[0014] Consequently, also in the optical path from a record medium to a photodetector, wave aberration can be amended good. Therefore, it becomes possible to perform record/playback good, without the spot on a photodetector expanding or deforming. In addition, since the aberration generally generated in the 1st optical path from laser to $\lambda/4$ plate and the aberration generated in the 2nd optical path from a record medium to a photodetector are mutually equal, the amount of amendments of the liquid crystal device which amends the aberration of the 1st optical path from laser to $\lambda/4$ plate, and the liquid crystal device which amends the aberration of the 2nd optical path from a record medium to a photodetector is the same, and good. That is, the amount and distribution which orientation only lies at right angles and control the liquid crystal device of two sheets will become the same.

[0015] Hereafter, the concrete example in the gestalt of this operation is explained to a detail using a drawing.

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EXAMPLE

(The 1st example) Drawing 1 is the approximate account Fig. showing the configuration of the optical system of the optical pickup by the 1st example of this invention. An optical disk 8 is a phase change mold disk or a ROM disk of a metal membrane, cover glass 7 is penetrated, laser light is irradiated by the signal recording surface, and the pit pattern recorded on the signal recording surface is read by the optical pickup. An optical pickup has the biaxial actuator 9 carrying an objective lens 6, by drive control of this biaxial actuator 9, moves an objective lens 6 in the direction of a focus, and the direction of tracking, and performs access to an optical disk 8.

[0016] A collimator lens 2, a polarization beam splitter (optical branching component) 3, liquid crystal device A4, the liquid crystal device B10, and the quarter-wave length plate (phase control component) 5 are formed in the optical path between the laser light source (LD) 1 and an objective lens 6. Moreover, the focusing glass 11 and the multi-lens 12 are formed in the optical path of a polarization beam splitter 3 and a photodetector 13. Among these, liquid crystal device A4 and a liquid crystal device B10 constitute the wave aberration compensator in this gestalt, liquid crystal device A4 amends the wave aberration of the laser light which carries out incidence to an optical disk 8 from LD1, and a liquid crystal device B10 amends the wave aberration of the return laser light reflected with the optical disk 8. In addition, since it is the same configuration as usual, others are omitted for details.

[0017] Next, the configuration and actuation of a wave aberration compensator in the optical pickup of such this gestalt are explained. Drawing 2 is liquid crystal device A4 used by this example, and the explanatory view showing the structure of B10. Liquid crystal device A4 used by this example and B10 change and arrange the include angle of the liquid crystal device 20 which has common structure mutually, drawing 2 (A) shows the condition at the time of power-source OFF of a liquid crystal device 20, and drawing 2 (B) shows the condition at the time of power-source ON of a liquid crystal device 20. Moreover, drawing 2 (C) shows the forward plane structure of the electrode of a liquid crystal device 20. Like illustration, the liquid crystal device 20 of this example closes the liquid crystal molecule 23 with the glass substrates 21 and 22 of a pair. The electrode layers 24 and 25 for impressing an electrical potential difference to liquid crystal are formed in the opposed face of each glass substrates 21 and 22 according to the power source 26, and the orientation film 27 and 28 is further formed inside each electrode layers 24 and 25. Moreover, as shown in drawing 2 (C), each electrode layers 24 and 25 are divided in the shape of a concentric circle, and acquire the distribution of voltage impressed to liquid crystal by impressing the electrical potential difference of level which is different in each division electrode layer.

[0018] Such a liquid crystal device 20 has the array of the liquid crystal molecule which met the orientation film 27 and 28 at the time of OFF of a power source 26, as shown in drawing 2 (A). And since the liquid crystal molecule which was lying down along the direction of a field of each substrates 21 and 22 will start and a refractive index will change as shown in drawing 2 (B) if a power source 26 is turned on, it is possible to give phase distribution to the transmitted light. In this example, the variation rate of the phase distribution is carried out by the liquid crystal device B10 to the linearly polarized light of the laser light of the return trip (return) which is

made to carry out the variation rate of the phase distribution, reflects from an optical disk 8, and carries out incidence to a photodetector 13 by liquid crystal device A4 to the linearly polarized light of the laser light of the outward trip (going) which carries out incidence to an optical disk 8 by using such a liquid crystal device 20 for liquid crystal device A4 and B10.

[0019] In addition, although the distribution of voltage impressed to liquid crystal with a division electrode was acquired in the liquid crystal device 20 shown in drawing 2, the liquid crystal device 30 constituted so that a substrate configuration might instead be deformed and the thickness of a liquid crystal molecule might serve as phase distribution and the similarity configuration of aberration, as shown in drawing 3 may be used. That is, in the example shown in drawing 3, the medial surface of one glass substrate 31 of a liquid crystal device 30 has a curvilinear configuration respectively like illustration, and solid formation of the orientation film 37 and the electrode layer 34 is carried out at the medial surface of these glass substrates 31. Moreover, as shown in drawing 3 (C), the electrode layers 34 and 35 of a liquid crystal device 30 are not divided, respectively, but an electrical potential difference common to the whole is impressed according to a power source 36. In addition, the glass substrate 32 and the liquid crystal molecule 33 of another side, and electrode layer 35 grade are as common as the example shown in drawing 2 mentioned above. Also in liquid crystal device A4 using such a liquid crystal device 30, and B10, liquid crystal device A4 mentioned above and the same operation as B10 can be acquired.

[0020] Next, actuation of the wave aberration compensator of the above configurations is explained. First, desired phase distribution is given by 1st liquid crystal device A4 to which the linearly polarized light which faces to an optical disk 8 from the polarization beam splitter prism (PBS) 3 has the orientation film 27 and 28 in the polarization direction. That is, in liquid crystal device A4, since the liquid crystal molecule which was lying down on the front face of each substrates 21 and 22 will start and a refractive index will change if an electrical potential difference is applied to each electrode layers 24 and 25, it is possible to give phase distribution to the transmitted light. On the other hand, since the 2nd liquid crystal device B10 is making the polarization direction and the orientation film cross at right angles, it does not affect the transmitted light in the optical path from LD1 to an optical disk 8. The light which penetrated liquid crystal device A4 turns into the circular polarization of light with $\lambda/4$ plate 5, and is condensed in respect of the signal of an optical disk 8 with an objective lens 6. Here, the aberration of the optical system of an outward trip (going) is amended by the phase distribution given by liquid crystal device A4, and the spot of a diffraction limitation is obtained by the signal recording surface of an optical disk 8.

[0021] Next, the light reflected with the optical disk 8 turns into the linearly polarized light which intersects perpendicularly with an outward trip through $\lambda/4$ plate 5 again. This linearly polarized light can give desired phase distribution by the liquid crystal device B10 which has the orientation film 27 and 28 in that polarization direction. On the other hand, since the polarization direction and the orientation film 27 and 28 are made to cross at right angles in liquid crystal device A4, the transmitted light is not affected in the optical path from $\lambda/4$ plate 5 to a photodetector 13. This amends the aberration of the light which has returned from the signal recording surface of an optical disk 8. The light which penetrated the liquid crystal device B10 is reflected by PBS3, and a focal error signal, a tracking error signal, and a RF signal are detected from the output of this photodetector 13 toward a photodetector 13. Here, if big aberration remains in return light, the spot on a photodetector 13 will expand or deform, exact detection cannot be performed, but in this example, since the aberration of return light is amended by the liquid crystal device B10, good detection is attained. In addition, the same effectiveness is acquired even if the physical relationship of liquid crystal device A4 and a liquid crystal device B10 is contrary to the arrangement shown in drawing 1.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the explanatory view showing the example of a configuration of the optical system of the optical pickup in the 1st example of this invention.

[Drawing 2] It is the explanatory view showing the 1st example of a liquid crystal device prepared in the optical pickup shown in drawing 1 .

[Drawing 3] It is the explanatory view showing the 2nd example of a liquid crystal device prepared in the optical pickup shown in drawing 1 .

[Drawing 4] It is the explanatory view showing the example of a configuration of the optical system of the optical pickup by the 2nd example of this invention.

[Drawing 5] It is the explanatory view showing the example of a configuration of the optical system of the optical pickup by the 3rd example of this invention.

[Drawing 6] It is the explanatory view showing the example of a configuration of the optical system of the optical pickup by the 4th example of this invention.

[Drawing 7] It is the explanatory view showing the example of a configuration of the optical system of the optical pickup by the 5th example of this invention.

[Drawing 8] It is the explanatory view showing the example of a liquid crystal device prepared in the optical pickup shown in drawing 7 .

[Description of Notations]

1 [.. A liquid crystal device A, 5 / .. A quarter-wave length plate, 6 / .. An objective lens, 7 / .. Cover glass, 8 / .. An optical disk, 9 / .. A biaxial actuator, 10 / .. A liquid crystal device B, 11 / .. A focusing glass, 12 / .. A multi-lens, 13 / .. Photodetector.] The laser light source (LD), 2 .. A collimator lens, 3 .. A polarization beam splitter (PBS), 4

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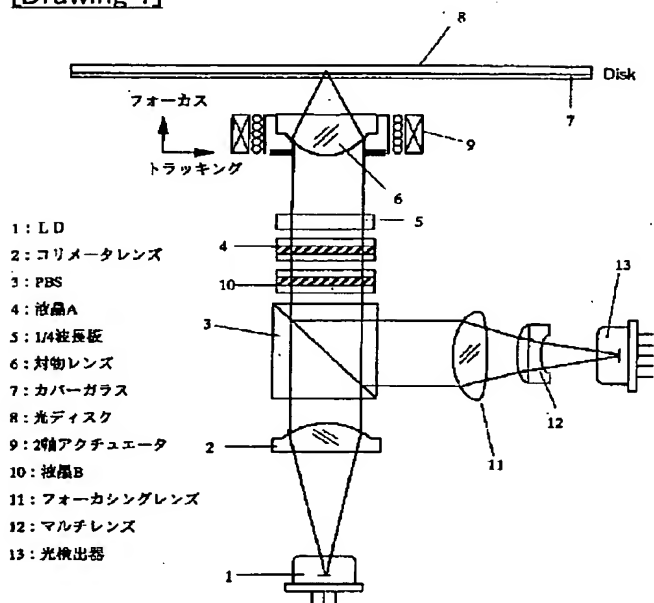
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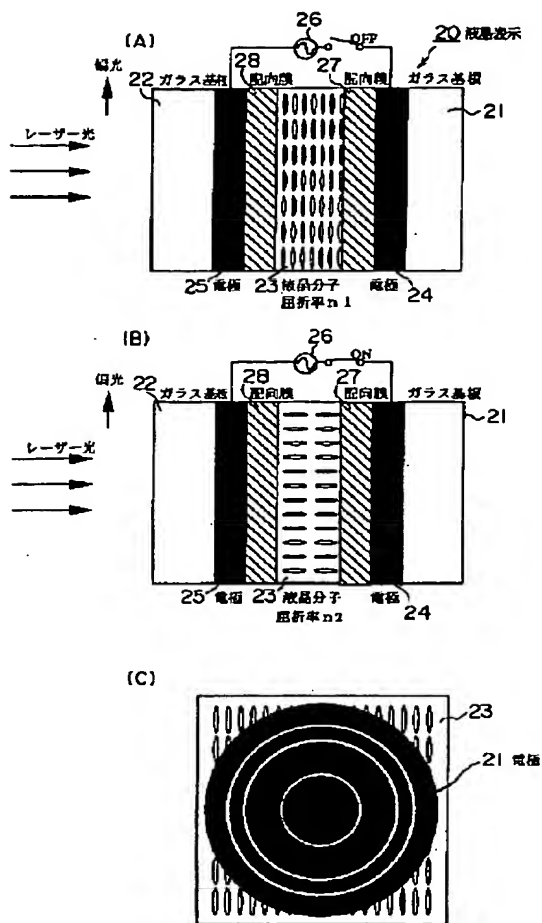
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DRAWINGS

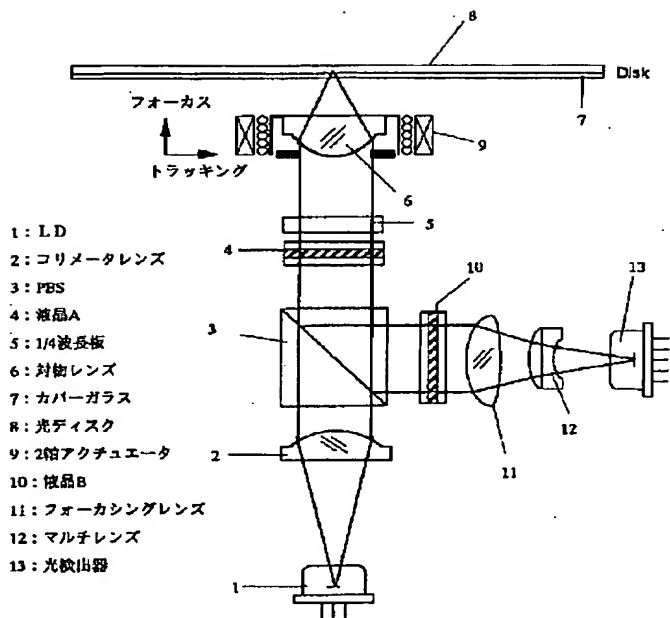
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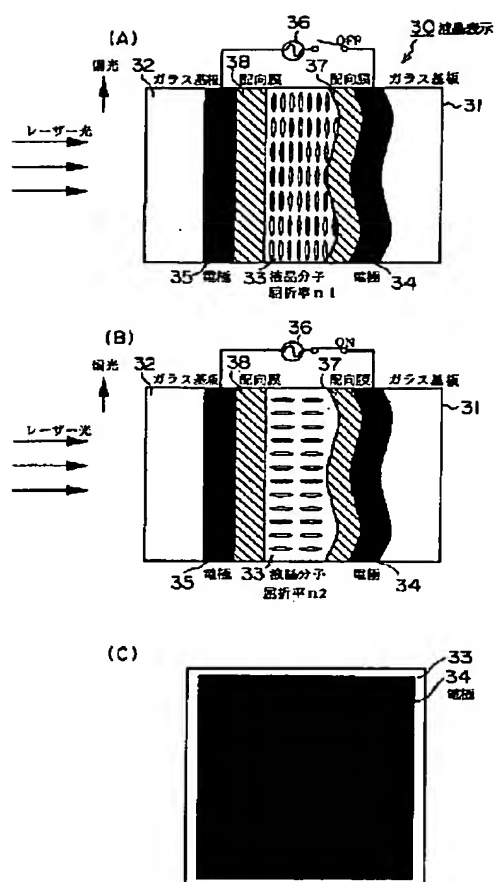
[Drawing 2]



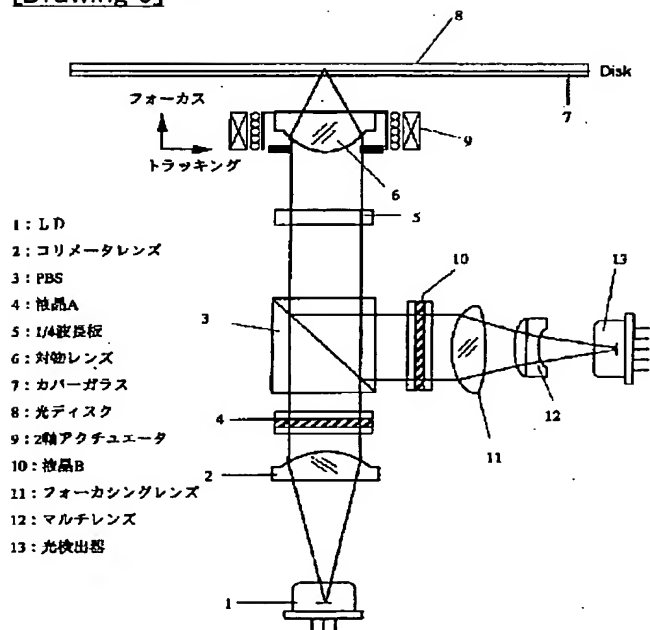
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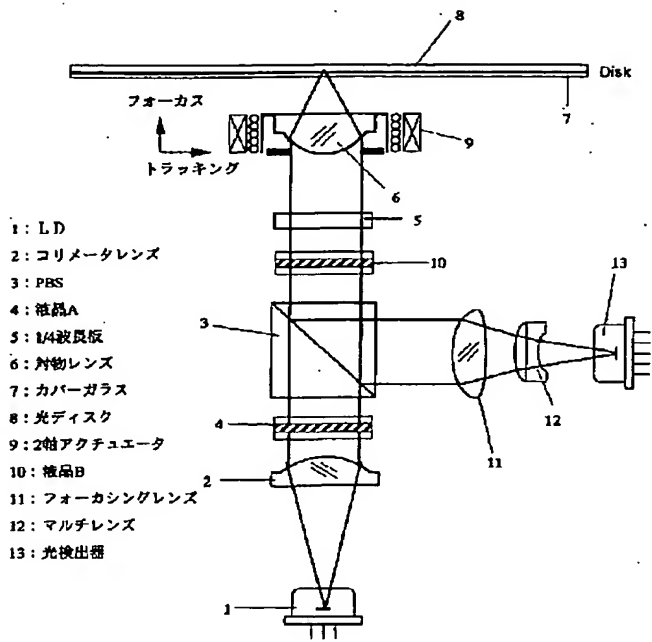
[Drawing 3]



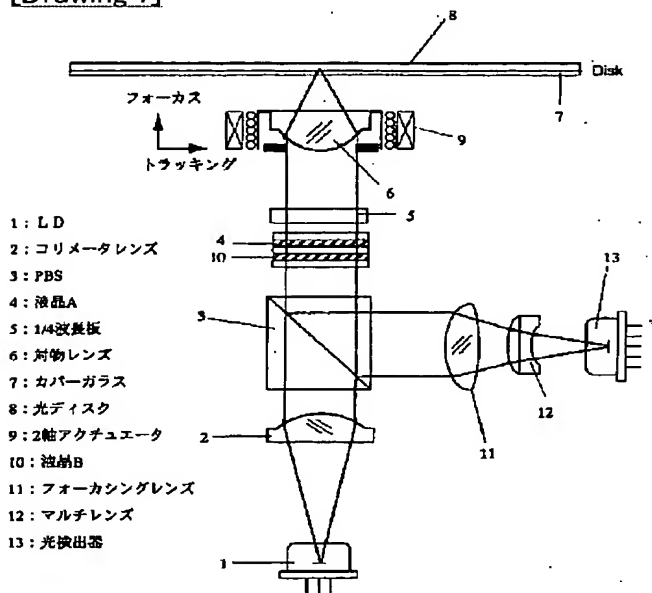
[Drawing 5]



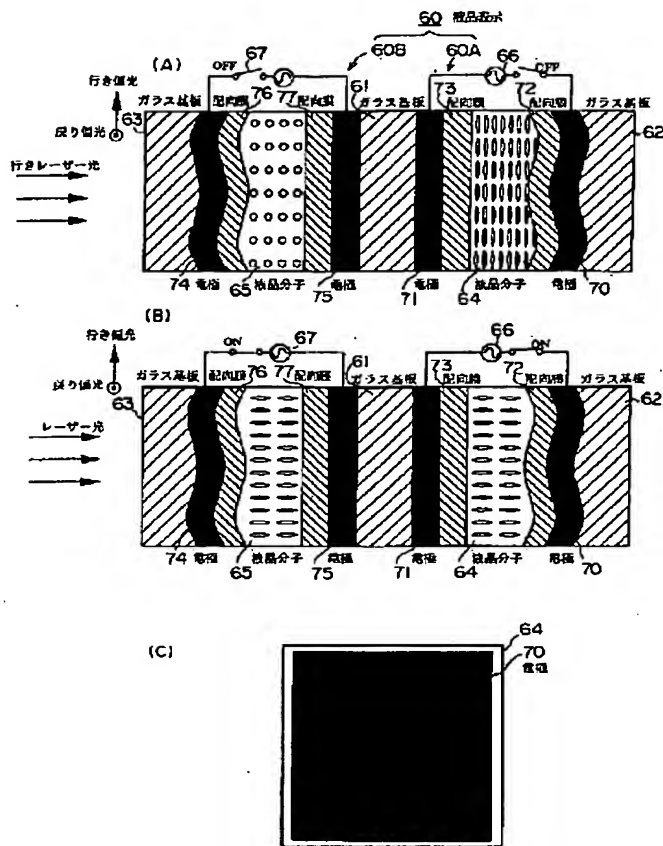
[Drawing 6]



[Drawing 7]



[Drawing 8]



[Translation done.]

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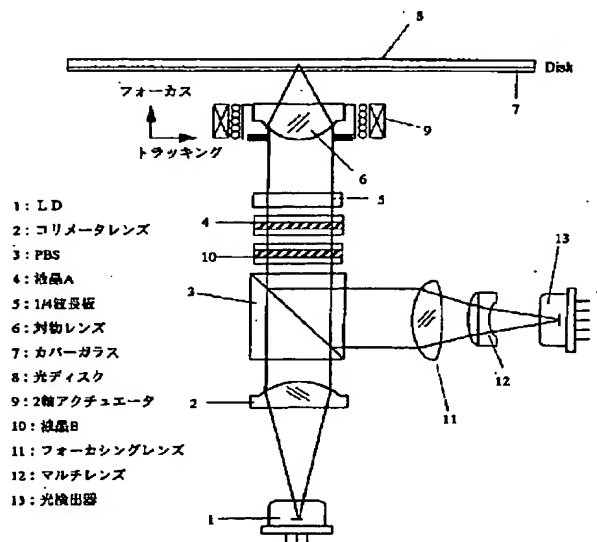
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(54) 【発明の名称】 光ピックアップ及びその波面収差補正装置

(57) 【要約】

【課題】 光源から記録媒体を経て光検出器に到る光路上に配置される1/4波長板の影響を受けることなく、光学系に生じる波面収差を液晶素子によって適正に補正する。

【解決手段】 レーザー光源1から光ディスク3までの行き光路(第1の光路)の液晶素子A4を配置し、光ディスク3に入射する光の偏光方向に液晶を配向するようにして、行き光の収差を補正する。また、この液晶素子A4とは別にλ/4板5から光検出器13までの戻り光路(第2の光路)に液晶素子B10を追加配置し、戻り光の偏光方向に液晶を配向するようにして、戻り光の収差を補正する。これにより、行きと戻りで偏光状態が90度異なるので、収差は、それぞれ独立に補正される。



【特許請求の範囲】

【請求項 1】 光源からの光を光記録媒体に入射させ、その反射光を光検出器によって検出することにより、前記光記録媒体に記録された情報の少なくとも再生を行なう光ピックアップにおいて、前記光源から光記録媒体に到る第 1 の光路に波面収差補正用の第 1 の液晶素子を設けるとともに、前記光記録媒体から光検出器に到る第 2 の光路に波面収差補正用の第 2 の液晶素子を設けた、ことを特徴とする光ピックアップ。

【請求項 2】 前記光源から出射された光を前記光記録媒体の情報記録面に集光させるための対物レンズと、前記光源と対物レンズとの間に配置された位相制御素子と、前記光源と位相制御素子との間に配置され、前記光源からの光を光記録媒体側に導くとともに、前記光記録媒体からの反射光を前記光検出器に導く光分岐素子とを有し、前記第 1 の液晶素子は前記光源と対物レンズとの間に配置され、前記第 2 の液晶素子は前記位相制御素子と光検出器との間に配置されていることを特徴とする請求項 1 記載の光ピックアップ。

【請求項 3】 前記第 1 の液晶素子は前記光記録媒体に入射する光の偏光方向に液晶を配向するように配置し、前記第 2 の液晶素子は前記光検出器に入射する光の偏光方向に液晶を配向するように配置したことを特徴とする請求項 2 記載の光ピックアップ。

【請求項 4】 前記第 1 の液晶素子及び第 2 の液晶素子は前記位相制御素子と光分岐素子の間に配置されていることを特徴とする請求項 2 記載の光ピックアップ。

【請求項 5】 前記第 1 の液晶素子は前記位相制御素子と光分岐素子の間に配置され、前記第 2 の液晶素子は前記光分岐素子と光検出器との間に配置されていることを特徴とする請求項 2 記載の光ピックアップ。

【請求項 6】 前記第 1 の液晶素子は前記光源と光分岐素子の間に配置され、前記第 2 の液晶素子は前記光分岐素子と光検出器との間に配置されていることを特徴とする請求項 2 記載の光ピックアップ。

【請求項 7】 前記第 1 の液晶素子と第 2 の液晶素子が中間基板を共有して一体化された液晶素子よりなることを特徴とする請求項 1 記載の光ピックアップ。

【請求項 8】 前記位相制御素子は 1/4 波長板であることを特徴とする請求項 2 記載の光ピックアップ。

【請求項 9】 前記光分岐素子は偏光ビームスプリッタであることを特徴とする請求項 2 記載の光ピックアップ。

【請求項 10】 前記光記録媒体はディスク型媒体であることを特徴とする請求項 1 記載の光ピックアップ。

【請求項 11】 前記光源はレーザー光源であることを特徴とする請求項 1 記載の光ピックアップ。

【請求項 12】 光源からの光を光記録媒体に入射させ、その反射光を光検出器によって検出することによ

り、前記光記録媒体に記録された情報の少なくとも再生を行なう光ピックアップの波面収差補正装置において、前記光源から光記録媒体に到る第 1 の光路に配置される波面収差補正用の第 1 の液晶素子と、前記光記録媒体から光検出器に到る第 2 の光路に配置される波面収差補正用の第 2 の液晶素子と、を有することを特徴とする光ピックアップの波面収差補正装置。

【請求項 13】 前記光ピックアップは、前記光源から出射された光を前記光記録媒体の情報記録面に集光させるための対物レンズと、前記光源と対物レンズとの間に配置された位相制御素子と、前記光源と位相制御素子との間に配置され、前記光源からの光を光記録媒体側に導くとともに、前記光記録媒体からの反射光を前記光検出器に導く光分岐素子とを有し、前記第 1 の液晶素子は前記光源と対物レンズとの間に配置され、前記第 2 の液晶素子は前記位相制御素子と光検出器との間に配置されていることを特徴とする請求項 12 記載の光ピックアップの波面収差補正装置。

【請求項 14】 前記第 1 の液晶素子は前記光記録媒体に入射する光の偏光方向に液晶を配向するように配置し、前記第 2 の液晶素子は前記光検出器に入射する光の偏光方向に液晶を配向するように配置したことを特徴とする請求項 13 記載の光ピックアップの波面収差補正装置。

【請求項 15】 前記第 1 の液晶素子及び第 2 の液晶素子は前記位相制御素子と光分岐素子の間に配置されていることを特徴とする請求項 13 記載の光ピックアップの波面収差補正装置。

【請求項 16】 前記第 1 の液晶素子は前記位相制御素子と前記光分岐素子の間に配置され、前記第 2 の液晶素子は前記光分岐素子と光検出器との間に配置されていることを特徴とする請求項 13 記載の光ピックアップの波面収差補正装置。

【請求項 17】 前記第 1 の液晶素子は前記光源と光分岐素子の間に配置され、前記第 2 の液晶素子は前記光分岐素子と光検出器との間に配置されていることを特徴とする請求項 13 記載の光ピックアップの波面収差補正装置。

【請求項 18】 前記第 1 の液晶素子と第 2 の液晶素子が中間基板を共有して一体化された液晶素子よりなることを特徴とする請求項 12 記載の光ピックアップの波面収差補正装置。

【請求項 19】 前記位相制御素子は 1/4 波長板であることを特徴とする請求項 13 記載の光ピックアップの波面収差補正装置。

【請求項 20】 前記光分岐素子は偏光ビームスプリッタであることを特徴とする請求項 13 記載の光ピックアップの波面収差補正装置。

【請求項 21】 前記光記録媒体はディスク型媒体であ

ることを特徴とする請求項 1 2 記載の光ピックアップの波面収差補正装置。

【請求項 2 2】 前記光源はレーザー光源であることを特徴とする請求項 1 2 記載の光ピックアップの波面収差補正装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、光ディスクシステム、光磁気ディスクシステム、光カードシステムなどの各種光学式記録及び／または再生装置に用いられる光ピ

【0002】

【従来の技術】近年、光ディスクを用いた各種の記録／再生装置においては、光ディスクの記録容量を高めるために、光ピックアップの光源としては短波長の半導体レーザー（LD）が利用され、また、対物レンズとしては開口率NAの高いレンズが用いられている。すなわち、光ピックアップの光源に用いられるレーザーの波長は、例えばCDでは780nm、DVDでは650nmというように、記録密度が高くなるに従って短くなっている。一方、対物レンズのNAは、例えばCDでは0.45、DVDでは0.60、というように、記録密度が高くなるに従って大きくなっている。また、最近では405nmという青紫色のLDと、0.85という高NA対物レンズが光ディスクの開発に用いられている。

【0003】しかしながら、このようにLDの波長が短くなり、かつ、対物レンズのNAが大きくなると、種々の製造誤差に対して容易に波面収差が増大し、光学性能が劣化するという問題が生じる。そこで、この波面収差を補正する方法として、従来より様々な方法が考えられてきており、その1つに液晶素子を用いる方法がある。これはレーザーと対物レンズとの間に液晶素子を挿入し、透過光に所望の位相分布を与えるものである。すなわち、波面収差と逆の位相を対物レンズの入射光に予め与えることにより、結像面で無収差状態を得るものである。

【0004】以下、液晶素子で透過光に位相分布を与える方法について説明する。まず、一般に液晶素子の液晶分子を封止する2つの基板には、通常はガラス製の平面基板が用いられており、これらガラス基板には、液晶に電圧を印加できるように電極が形成されている。そして、これらガラス基板内に封止される液晶分子は、各ガラス基板に形成された配向膜に沿って並んでおり、各ガラス基板の電極に電圧を印加することにより分子配列を変位させることができる。そして、この液晶分子の変位に伴い、配向膜に沿った方向の偏光成分に対しては屈折率が変わるので、透過光の位相を変えることが可能である。一方、配向膜と直交方向の偏光に対しては、電圧の印加にかかわらず、屈折率は一定なので位相変化は起こらない。

【0005】次に、このような配向膜と平行な偏光の透過光に位相分布を与えるには、液晶に印加する電圧分布を作ればよい。そのための簡単な方法としては、電極を少なくとも2つ以上に分割された電極で形成し、これらの電極に所望の位相分布に従った電圧を別々に加える方法がある。このような方法により、電極数と印加電圧に見合った電圧分布を形成し、近似的に所望の位相分布を透過光に与えることが可能となる。この場合、もちろん分割数が細かいほど理想的な位相分布を発生できる。

【0006】また、液晶に印加する電圧分布を与える他の方法として、各ガラス基板の液晶を挟み込む面の面形状を、液晶分子の厚みが収差の位相分布と相似形状となるように構成する方法がある。この場合、電極は分割することなく各基板面に対してベタに形成する。そして、電極には一様の電圧を印加する。この方法では、透過光の位相分布は透過する液晶分子の厚みと印加する電圧で決まる。そして、透過光に液晶素子がない場合の光学系が有する波面収差と逆の位相分布を与えれば、結像面では無収差となる。

【0007】

【発明が解決しようとする課題】しかしながら、上述のような液晶素子を用いた波面収差補正手段においては、記録媒体から光検出器までの光路に発生する以下のような問題点がある。すなわち、例えば相変化型ディスクの記録／再生、あるいはROMディスクの再生などを行なう場合には、レーザーから1/4波長板（以下、λ/4板という）までの光路とλ/4板から光検出器までの光路とで偏光状態が直交していることになる。したがって、液晶素子を用いてレーザーから記録媒体までの光路の光学系の収差を補正しても、λ/4板から光検出器までの光路では、配向膜と偏光が直交しているために、記録媒体から光検出器までの光路の収差は補正されない。この状態で検出系で信号を検出すると、記録媒体から光検出器までの光路に大きな収差が残っている場合には、光検出器上でのスポットが拡大あるいは変形してしまい、正確な検出ができなくなり、良好な記録／再生が行なえないという問題が生じる。

【0008】そこで本発明の目的は、光源から記録媒体を経て光検出器に到る光路上に配置される波長板の影響を受けることなく、光学系に生じる波面収差を液晶素子によって適正に補正することが可能な光ピックアップ及びその波面収差補正装置を提供することにある。

【0009】

【課題を解決するための手段】本発明は前記目的を達成するため、光源からの光を光記録媒体に入射させ、その反射光を光検出器によって検出することにより、前記光記録媒体に記録された情報の少なくとも再生を行なう光ピックアップにおいて、前記光源から光記録媒体に到る第1の光路に波面収差補正用の第1の液晶素子を設けるとともに、前記光記録媒体から光検出器に到る第2の光

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路に波面収差補正用の第2の液晶素子を設けたことを特徴とする。また本発明は、光源からの光を光記録媒体に入射させ、その反射光を光検出器によって検出することにより、前記光記録媒体に記録された情報の少なくとも再生を行なう光ピックアップの波面収差補正装置において、前記光源から光記録媒体に到る第1の光路に配置される波面収差補正用の第1の液晶素子と、前記光記録媒体から光検出器に到る第2の光路に配置される波面収差補正用の第2の液晶素子とを有することを特徴とする。

【0010】本発明の光ピックアップでは、光源から光記録媒体に到る第1の光路に波面収差補正用の第1の液晶素子を設け、光記録媒体に入射する光の波面収差を補正する。また、光記録媒体から光検出器に到る第2の光路に波面収差補正用の第2の液晶素子を設け、光記録媒体から反射して光検出器に入射する光の波面収差を補正する。したがって、特に第2の液晶素子を新たに設けたことにより、光記録媒体から光検出器までの光路の収差も補正できるので、例えばフォーカス誤差信号、トラッキング誤差信号、RF信号の良好な検出状態が可能となり、大きな収差を補正する場合の光ピックアップの性能向上に寄与することが可能となる。

【0011】また本発明の波面収差補正装置でも同様に、光源から光記録媒体に到る第1の光路に波面収差補正用の第1の液晶素子を設け、光記録媒体に入射する光の波面収差を補正する。また、光記録媒体から光検出器に到る第2の光路に波面収差補正用の第2の液晶素子を設け、光記録媒体から反射して光検出器に入射する光の波面収差を補正する。したがって、特に第2の液晶素子を新たに設けたことにより、光記録媒体から光検出器までの光路の収差も補正できるので、例えばフォーカス誤差信号、トラッキング誤差信号、RF信号の良好な検出状態が可能となり、大きな収差を補正する場合の光ピックアップの性能向上に寄与することが可能となる。

【0012】

【発明の実施の形態】以下、本発明による光ピックアップ及びその波面収差補正装置の実施の形態について説明する。なお、以下に説明する実施の形態は、本発明の好適な具体例であり、技術的に好ましい種々の限定が付されているが、本発明の範囲は、以下の説明において、特に本発明を限定する旨の記載がない限り、これらの態様に限定されないものとする。

【0013】本実施の形態では、上述した従来例におけるレーザー光源から記録媒体までの光路（第1の光路）の液晶素子とは別に、 $\lambda/4$ 板から光検出器までの光路（第2の光路）に液晶素子を追加配置し、戻り光の偏光方向に液晶を配向するようにして戻りの収差を補正するようにしたものである。このような構成により、行きと戻りで偏光状態が90度異なるので、収差は、それぞれ独立に補正される。この液晶素子を配置する場所は、戻りの光路であればどこでもよく、行きと戻りが重なって

いる場所であってもよい。

【0014】この結果、記録媒体から光検出器までの光路においても、波面収差を良好に補正することができる。したがって、光検出器上でのスポットが拡大あるいは変形することなく、記録／再生を良好に行うことが可能となる。なお、一般にレーザーから $\lambda/4$ 板までの第1の光路で発生する収差と、記録媒体から光検出器までの第2の光路で発生する収差とは互いに等しいので、レーザーから $\lambda/4$ 板までの第1の光路の収差を補正する液晶素子と、記録媒体から光検出器までの第2の光路の収差を補正する液晶素子の補正量は同じでよい。すなわち、2枚の液晶素子は配向が直交しているだけで、制御する量や分布は同じものとなる。

【0015】以下、本実施の形態における具体的な実施例について図面を用いて詳細に説明する。

（第1実施例）図1は、本発明の第1実施例による光ピックアップの光学系の構成を示す概略説明図である。光ディスク8は、相変化型ディスクあるいは金属膜のROMディスクであり、カバーガラス7を透過して信号記録面にレーザー光が照射され、信号記録面に記録されたビットパターンが光ピックアップによって読み出される。光ピックアップは、対物レンズ6を搭載した2軸アクチュエータ9を有し、この2軸アクチュエータ9の駆動制御によって対物レンズ6をフォーカス方向及びトラッキング方向に移動し、光ディスク8へのアクセスを行なう。

【0016】レーザー光源（LD）1と対物レンズ6との間の光路には、コリメータレンズ2、偏光ビームスプリッタ（光分岐素子）3、液晶素子A4、液晶素子B10、及び $\lambda/4$ 波長板（位相制御素子）5が設けられている。また、偏光ビームスプリッタ3と光検出器13との光路には、フォーカシングレンズ11、及びマルチレンズ12が設けられている。このうち、液晶素子A4及び液晶素子B10が、本形態における波面収差補正装置を構成するものであり、液晶素子A4はLD1から光ディスク8に入射するレーザー光の波面収差を補正するものであり、液晶素子B10は光ディスク8で反射した戻りレーザー光の波面収差を補正するものである。なお、その他は、従来と同様の構成であるので詳細は省略する。

【0017】次に、このような本形態の光ピックアップにおける波面収差補正装置の構成及び動作について説明する。図2は、本例で用いる液晶素子A4、B10の構造を示す説明図である。本例で用いる液晶素子A4、B10は、互いに共通の構造を有する液晶素子20の角度を変えて配置したものであり、図2（A）は液晶素子20の電源オフ時の状態を示し、図2（B）は液晶素子20の電源オン時の状態を示している。また、図2（C）は液晶素子20の電極の正面構造を示している。図示のように、本例の液晶素子20は、一対のガラス基板2

1、22によって液晶分子23を封止したものである。各ガラス基板21、22の対向面には、電源26によって液晶に電圧を印加するための電極膜24、25が設けられており、さらに各電極膜24、25の内側に配向膜27、28が形成されている。また、各電極膜24、25は、図2(C)に示すように、同心円状に分割されており、各分割電極膜に異なるレベルの電圧を印加することにより、液晶に印加する電圧分布を得るようになって

【0018】このような液晶素子20は、図2(A)に示すように、電源26のオフ時において、配向膜27、28に沿った液晶分子の配列を有している。そして、電源26をオンすると、図2(B)に示すように、各基板21、22の面方向に沿って寝ていた液晶分子が立ち上がり、屈折率が変わるので、透過光に位相分布を与えることが可能である。本例では、このような液晶素子20を液晶素子A4、B10に用いることにより、光ディスク8に入射する往路(行き)のレーザー光の直線偏光に対しては液晶素子A4によって位相分布を変位させ、光ディスク8から反射して光検出器13に入射する復路(戻り)のレーザー光の直線偏光に対しては液晶素子B10によって位相分布を変位させるものである。

【0019】なお、図2に示す液晶素子20では、分割電極によって液晶に印加する電圧分布を得るようにしたが、この代わりに図3に示すように、基板形状を変形し、液晶分子の厚みが収差の位相分布と相似形状となるように構成した液晶素子30を用いてもよい。すなわち、図3に示す例では、液晶素子30の一方のガラス基板31の内側面がそれぞれ図示のような曲線形状を有しており、これらガラス基板31の内側面に配向膜37及び電極膜34がベタ形成されている。また、図3(C)に示すように、液晶素子30の電極膜34、35は、それぞれ分割されておらず、電源36によって全体に共通の電圧が印加される。なお、他方のガラス基板32や液晶分子33、電極膜35等は上述した図2に示す例と共通であるものである。このような液晶素子30を用いた液晶素子A4、B10においても、上述した液晶素子A4、B10と同様の作用を得ることができる。

【0020】次に、以上のような構成の波面収差補正装置の動作について説明する。まず、偏光ビームスプリッタプリズム(PBS)3から光ディスク8へ向かう直線偏光は、その偏光方向に配向膜27、28をもつ第1の液晶素子A4によって所望の位相分布が与えられる。すなわち、液晶素子A4において、各電極膜24、25に電圧を加えると各基板21、22の表面に寝ていた液晶分子が立ち上がり、屈折率が変わるので、透過光に位相分布を与えることが可能である。一方、第2の液晶素子B10は、配向膜を偏光方向と直交させているので、LD1から光ディスク8までの光路では透過光に影響を与えない。液晶素子A4を透過した光は、 $\lambda/4$ 板5で円

偏光となり、対物レンズ6により、光ディスク8の信号面で集光される。ここで、往路(行き)の光学系の収差は、液晶素子A4で与えられた位相分布で補正されており、光ディスク8の信号記録面で回折限界のスポットが得られる。

【0021】次に、光ディスク8で反射された光は、再び $\lambda/4$ 板5を通過して往路と直交する直線偏光となる。この直線偏光は、その偏光方向に配向膜27、28をもつ液晶素子B10によって所望の位相分布を与えられる。一方、液晶素子A4では、配向膜27、28を偏光方向と直交させているので、 $\lambda/4$ 板5から光検出器13までの光路では透過光に影響を与えない。これにより、光ディスク8の信号記録面から戻ってきた光の収差を補正する。液晶素子B10を透過した光は、PBS3で反射されて光検出器13へ向かい、この光検出器13の出力からフォーカス誤差信号、トラッキング誤差信号、RF信号が検出される。ここで、戻り光に大きな収差が残っていると、光検出器13上でのスポットが拡大あるいは変形して正確な検出ができないが、この実施例では、戻り光の収差が液晶素子B10により補正されているので、良好な検出が可能となる。なお、液晶素子A4と液晶素子B10の位置関係は、図1に示す配置と逆であっても同じ効果が得られる。

【0022】(第2実施例) 図4は、本発明の第2実施例による光ピックアップの光学系の構成を示す概略説明図である。この第2実施例は、上述した2つの液晶素子A4、B10の配置を変えたものであり、その他は上記第1実施例と同様であるので、共通の構成について同一符号を用いて説明する。本実施例では、第1の液晶素子A4については第1実施例と同様にPBS3と $\lambda/4$ 板5との間に配置しているが、第2の液晶素子B10はPBS3とフォーカシングレンズ11との間に配置したものである。なお、本実施例においても、液晶素子A4、B10自体の構成も第1実施例と同様であり、例えば図2または図3に示すものを用いるものとする。

【0023】次に、以上のような構成の波面収差補正装置の動作について説明する。PBS3から光ディスク8へ向かう直線偏光は、その偏光方向に配向膜27、28をもつ液晶素子A4によって所望の位相分布を与えられる。液晶素子A4を透過した光は、 $\lambda/4$ 板5で円偏光となり、対物レンズ6により光ディスク8の信号記録面で集光される。往路(行き)の光学系の収差は液晶素子A4で与えられた位相分布で補正されており、光ディスク8の信号記録面で回折限界のスポットが得られる。そして、光ディスク8で反射された光は、再び $\lambda/4$ 板5を通過して往路(行き)と直交する直線偏光となる。この直線偏光は、PBS3で反射され、その偏光方向に配向膜をもつ液晶素子B10によって所望の位相分布を与えられる。これにより、光ディスク8の信号記録面から戻ってきた光の収差を補正する。液晶素子B10を透過し

た光は、光検出器 13 へ向かい、フォーカス誤差信号、トラッキング誤差信号、RF 信号が検出される。ここで、戻り光に大きな収差が残っていると、光検出器 13 上でのスポットが拡大あるいは変形して正確な検出ができないが、この実施例では戻り光の収差が液晶素子 B 10 により補正されているので、良好な検出が可能となる。

【0024】（第 3 実施例）図 5 は、本発明の第 3 実施例による光ピックアップの光学系の構成を示す概略説明図である。この第 3 実施例も、上述した 2 つの液晶素子 A 4、B 10 の配置を変えたものであり、その他は上記第 1 実施例と同様であるので、共通の構成について同一符号を用いて説明する。本実施例は、第 1 の液晶素子 A 4 はコリメータレンズ 2 と PBS 3 との間に配置し、第 2 の液晶素子 B 10 は第 2 実施例と同様に PBS 3 とフォーカシングレンズ 11 との間に配置したものである。なお、本実施例においても、液晶素子 A 4、B 10 自体の構成も第 1 実施例と同様であり、例えば図 2 または図 3 に示すものを用いるものとする。

【0025】次に、以上のような構成の波面収差補正装置の動作について説明する。LD 1 から PBS 3 へ向かう直線偏光は、その偏光方向に配向膜 27、28 をもつ液晶素子 A 4 によって所望の位相分布を与えられる。液晶素子 A 4 を透過した光は、PBS 3 を透過して $\lambda/4$ 板 5 で円偏光となり、対物レンズ 6 によって光ディスク 8 の信号記録面で集光される。往路（行き）の光学系の収差は、液晶素子 A 4 で与えられた位相分布で補正されており、光ディスク 8 の信号回折限界のスポットが得られる。また、光ディスク 8 で反射された光は、再び $\lambda/4$ 板 5 を通って往路（行き）と直交する直線偏光となる。この直線偏光は、PBS 3 で反射され、その偏光方向に配向膜 27、28 をもつ液晶素子 B 10 によって所望の位相分布を与えられる。これにより、光ディスク 8 の信号記録面から戻ってきた光の収差を補正する。そして、この液晶素子 B 10 を透過した光は、光検出器 13 へ向かい、フォーカス信号誤差、トラッキング誤差信号、RF 信号が検出される。ここで、戻り光に大きな収差が残っていると、光検出器 13 上でのスポットが拡大あるいは変形して正確な検出ができないが、この実施例では、液晶素子 B 10 により、戻り光の収差が補正されているので、良好な検出が可能となる。

【0026】（第 4 実施例）図 6 は、本発明の第 4 実施例による光ピックアップの光学系の構成を示す概略説明図である。この第 4 実施例も、上述した 2 つの液晶素子 A 4、B 10 の配置を変えたものであり、その他は上記第 1 実施例と同様であるので、共通の構成について同一符号を用いて説明する。本実施例は、第 1 の液晶素子 A 4 は第 3 実施例と同様にコリメータレンズ 2 と PBS 3 との間に配置し、第 2 の液晶素子 B 10 は第 1 実施例と同様に PBS 3 と $\lambda/4$ 板 5 との間に配置したものであ

る。なお、本実施例においても、液晶素子 A 4、B 10 自体の構成も第 1 実施例と同様であり、例えば図 2 または図 3 に示すものを用いるものとする。

【0027】次に、以上のような構成の波面収差補正装置の動作について説明する。LD 1 から PBS 3 へ向かう直線偏光は、その偏光方向に配向膜をもつ液晶素子 A 4 によって所望の位相分布を与えられる。そして、この液晶素子 A 4 を透過した光は、PBS 3 を透過し、液晶素子 B 10 に入射する。この液晶素子 B 10 は、配向膜を偏光方向と直交させているので、透過光に影響を与えない。次に、液晶素子 A 4 を透過した光は、 $\lambda/4$ 板 5 で円偏光となり、対物レンズ 6 により光ディスク 8 の信号記録面で集光される。このような往路（行き）の光学系の収差は、液晶素子 A 4 で与えられた位相分布で補正されており、光ディスク 8 の信号記録面で回折限界のスポットが得られる。

【0028】次に、光ディスク 8 で反射された光は、再び $\lambda/4$ 板 5 を通って往路（行き）と直交する直線偏光となる。この直線偏光は、その偏光方向に配向膜をもつ液晶素子 B 10 によって所望の位相分布を与えられる。これにより、光ディスク 8 の信号記録面から戻ってきた光の収差を補正する。そして、この液晶素子 B 10 を透過した光は、PBS 3 で反射されて光検出器 13 へ向かい、フォーカス誤差信号、トラッキング誤差信号、RF 信号が検出される。ここで、戻り光に大きな収差が残っていると、光検出器 13 上でのスポットが拡大あるいは変形して正確な検出ができないが、この実施例では、戻り光の収差が液晶素子 B 10 により補正されているので、良好な検出が可能となる。

【0029】（第 5 実施例）図 7 は、本発明の第 5 実施例による光ピックアップの光学系の構成を示す概略説明図である。この第 5 実施例は、上述した 2 つの液晶素子 A 4、B 10 の代わりに、これら 2 つの液晶素子を一体化した液晶素子 60 を PBS 3 と $\lambda/4$ 板 5 との間に配置した例であり、その他は上記第 1 実施例と同様であるので、共通の構成について同一符号を用いて説明する。図 8 は、液晶素子 60 の構造を示す断面図であり、図 8 (A) は電源オフ時の状態を示し、図 8 (B) は電源オン時の状態を示している。また、図 8 (C) は液晶素子 60 の電極の正面構造を示している。

【0030】この液晶素子 60 は、平板状の中間ガラス基板 61 によって 2 つの液晶素子 60A、60B を一体化したものであり、両側のガラス基板 62、63 を図 3 に示した液晶素子 30 と同様に、それぞれの内側面で図示のような曲線状に形成し、各液晶分子 64、65 の厚みが収差の位相分布と相似形状となるように構成したものである。液晶素子 60A では、外側のガラス基板 62 の内側面に電極膜 70 及び配向膜 72 がベタで形成され、中間ガラス基板 61 の内側面に電極膜 71 及び配向膜 73 が平面状に形成され、その間に液晶分子 64 が封

止されている。この液晶素子 60A の液晶分子 64 の配向は、図 8 (A) に示すように、電源オフ時には、基板面に沿って、戻り偏光の方向に配置されている。

【0031】一方、液晶素子 60B では、外側のガラス基板 63 の内側面に電極膜 74 及び配向膜 76 がベタで形成され、中間ガラス基板 61 の内側面に電極膜 75 及び配向膜 77 が平面状に形成され、その間に液晶分子 65 が封止されている。この液晶素子 60B の液晶分子 65 の配向は、図 8 (A) に示すように、電源オフ時には、基板面に沿って、行き偏光の方向に配置されている。そして、このような液晶素子 60 では、各液晶素子 60A、60B の電源 66、67 をオンすると、図 8 (B) に示すように、各液晶分子 64、65 は光の透過方向に沿って配置される。なお、このような液晶素子 60 における液晶素子 60A と液晶素子 60B の位置関係は逆であっても同じ効果が得られる。

【0032】次に、以上のような構成の波面収差補正装置の動作について説明する。PBS 3 から光ディスク 8 へ向かう直線偏光は液晶素子 60 を透過する。この液晶素子 60 を構成する 2 つの液晶素子 60A、60B は、それぞれの液晶分子の配向が互いに直交しており、往路（行き）の光は、その偏光方向に配向膜をもつ液晶素子 60A（液晶素子 A 4）によって所望の位相分布を与えられる。また、これと 90 度の配向を有する液晶素子 60B（液晶素子 B 10）は光の位相分布に影響を与えない。そして、この液晶素子 60 を透過した光は、 $\lambda/4$ 板 5 で円偏光となり、対物レンズ 6 により光ディスク 8 の信号記録面で集光される。往路（行き）の光学系の収差は液晶素子 60A で与えられた位相分布で補正されており、光ディスク 8 の信号記録面で回折限界のスポットが得られる。

【0033】次に、光ディスク 8 で反射された光は、再び $\lambda/4$ 板 5 を通って往路（行き）と直交する直線偏光となる。この直線偏光は、その偏光方向に配向膜をもつ液晶素子 60B によって所望の位相分布を与えられる。これにより光ディスク 8 の信号記録面から戻ってきた光の収差を補正する。また、これと 90 度の配向を有する液晶素子 60A は、光の位相分布に影響を与えない。液晶素子 60 を透過した光は、PBS 3 で反射されて光検出器 13 へ向かい、フォーカス誤差信号、トラッキング誤差信号、RF 信号が検出される。ここで、戻り光に大きな収差が残っていると、光検出器 13 上でのスポットが拡大あるいは変形して正確な検出ができないが、この実施例では戻り光の収差が液晶素子 60B により補正されているので、良好な検出が可能となる。

【0034】なお、以上の各実施例では、行きと戻りの収差補正を行う 2 つの液晶素子 A、B を対物レンズ 6 と一体で駆動することが可能であり、これが望ましいものである。すなわち、対物レンズ 6 がトラッキング方向に駆動すると、液晶の中心と偏芯し、収差が発生する恐れ

がある。そこで、これを一体駆動によって防止することが可能である。また、以上の各実施例では、光記録媒体を光ディスクとした例について説明したが、本発明はこれに限らず、例えば光カードや光磁気ディスク等のシステムについても同様に適用可能である。また、本発明において光ピックアップとは、光源や光検出器を光ヘッドブロック内に搭載して一体に移動するものに限らず、光源や光検出器を光ヘッドブロックとは別に固定的に配置した構造のものをも含むものとする。

【0035】

【発明の効果】以上説明したように本発明の光ピックアップによれば、光源から光記録媒体に到る第 1 の光路に波面収差補正用の第 1 の液晶素子を設け、光記録媒体に入射する光の波面収差を補正するとともに、光記録媒体から光検出器に到る第 2 の光路に波面収差補正用の第 2 の液晶素子を設け、光記録媒体から反射して光検出器に入射する光の波面収差を補正することができる。したがって、特に第 2 の液晶素子を新たに設けたことにより、光記録媒体から光検出器までの光路の収差も補正できるので、例えばフォーカス誤差信号、トラッキング誤差信号、RF 信号の良好な検出状態が可能となり、大きな収差を補正する場合の光ピックアップの性能向上に寄与することが可能となる。

【0036】また本発明の波面収差補正装置によれば、光源から光記録媒体に到る第 1 の光路に波面収差補正用の第 1 の液晶素子を設け、光記録媒体に入射する光の波面収差を補正するとともに、光記録媒体から光検出器に到る第 2 の光路に波面収差補正用の第 2 の液晶素子を設け、光記録媒体から反射して光検出器に入射する光の波面収差を補正することができる。したがって、特に第 2 の液晶素子を新たに設けたことにより、光記録媒体から光検出器までの光路の収差も補正できるので、例えばフォーカス誤差信号、トラッキング誤差信号、RF 信号の良好な検出状態が可能となり、大きな収差を補正する場合の光ピックアップの性能向上に寄与することが可能となる。

【図面の簡単な説明】

【図 1】本発明の第 1 実施例における光ピックアップの光学系の構成例を示す説明図である。

【図 2】図 1 に示す光ピックアップに設けられる液晶素子の第 1 の例を示す説明図である。

【図 3】図 1 に示す光ピックアップに設けられる液晶素子の第 2 の例を示す説明図である。

【図 4】本発明の第 2 実施例による光ピックアップの光学系の構成例を示す説明図である。

【図 5】本発明の第 3 実施例による光ピックアップの光学系の構成例を示す説明図である。

【図 6】本発明の第 4 実施例による光ピックアップの光学系の構成例を示す説明図である。

【図 7】本発明の第 5 実施例による光ピックアップの光

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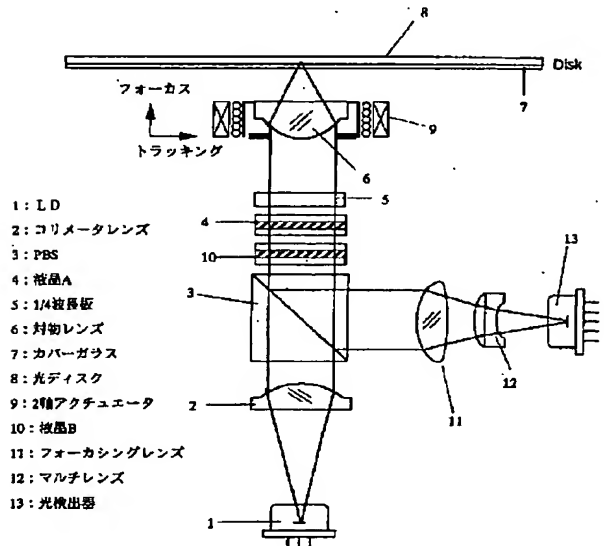
学系の構成例を示す説明図である。

【図8】図7に示す光ピックアップに設けられる液晶素子の例を示す説明図である。

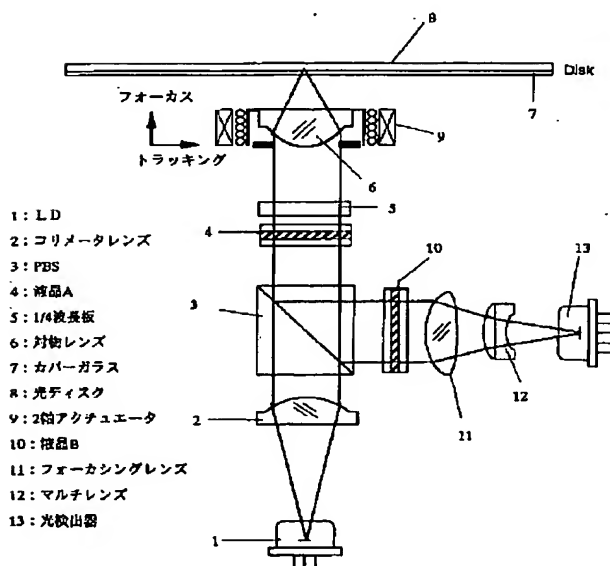
【符号の説明】

1……レーザー光源 (LD)、2……コリメータレンズ、3……偏光ビームスプリッタ (PBS)、4……液

【図1】



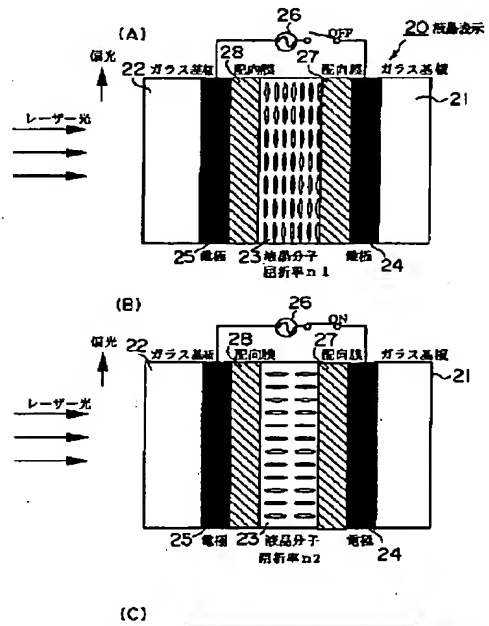
【図4】



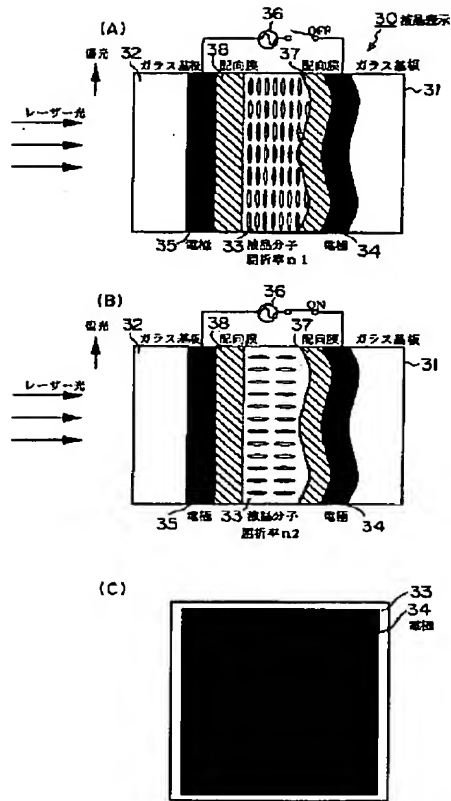
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晶素子A、5……1/4波長板、6……対物レンズ、7……カバーガラス、8……光ディスク、9……2軸アクチュエータ、10……液晶素子B、11……フォーカシングレンズ、12……マルチレンズ、13……光検出器。

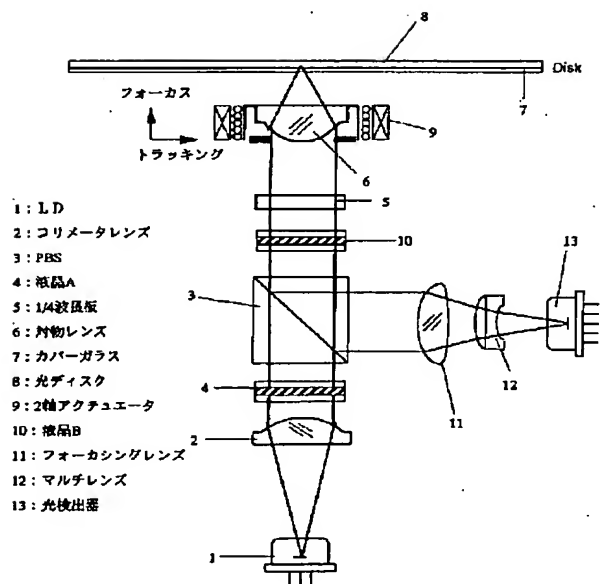
【図2】



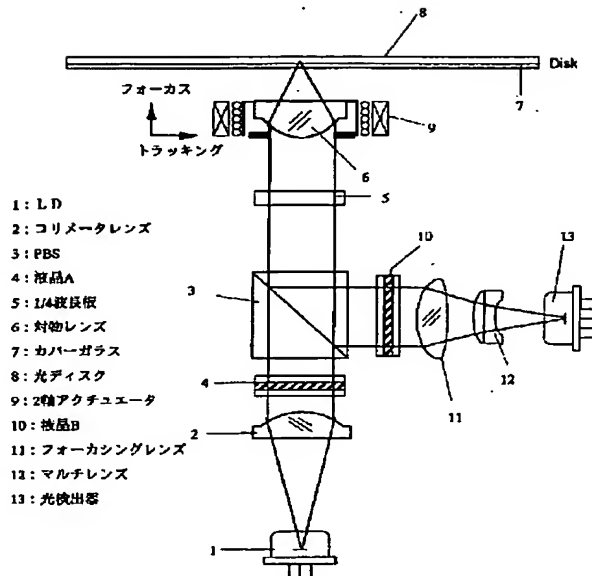
【図3】



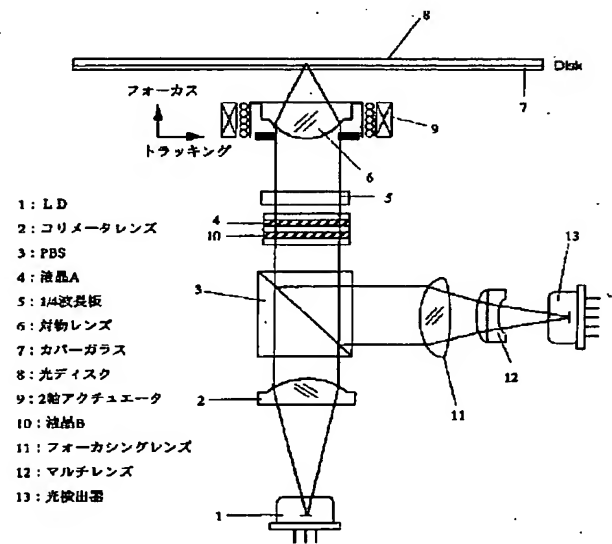
【図6】



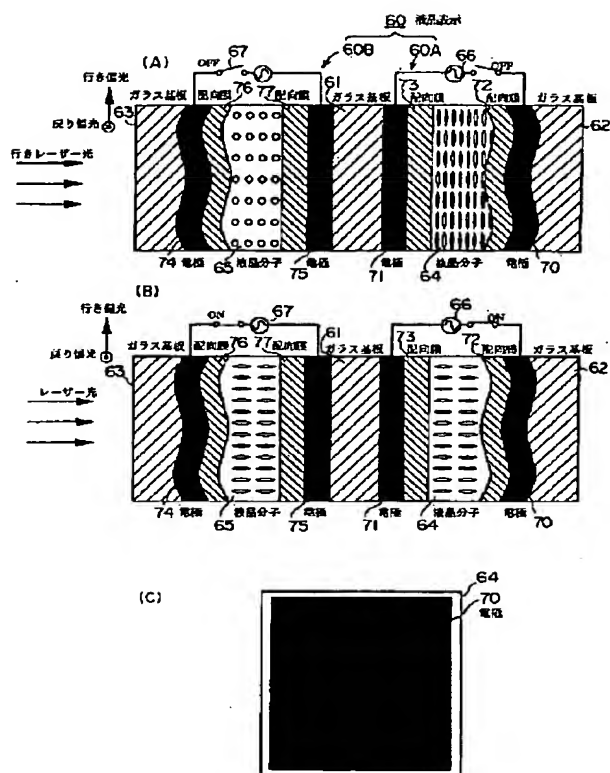
【図5】



【図7】



【図8】



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